APRIL 1961

Journal

VOL. 53 • NO. 4

AMERICAN WATER WORKS ASSOCIATION

In this issue:

Green shield program for water works structures as plants flourish in East Bay MUD

1961 AWWA CONFERENCE

Detroit, June 4-9

Journal

AMERICAN WATER WORKS ASSOCIATION

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April 1961

Vol. 53 No. 4

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Journal AWWA is published monthly at Prince & Lemon Sts., Lancaster, Pa., by the Am. Water Works Assn., Inc., 2 Park Ave., New York 16, N.Y. Second-class postage paid at Lancaster, Pa. Authorized Aug. 6, 1918. $8.00 of members' dues are applied as a subscription to the JOURNAL; additional single copies—85 cents. Indexed annually in December; and regularly by *Industrial Arts Index* and *Engineering Index*. Microfilm edition (for JOURNAL subscribers only) by University Microfilms, Ann Arbor, Mich.

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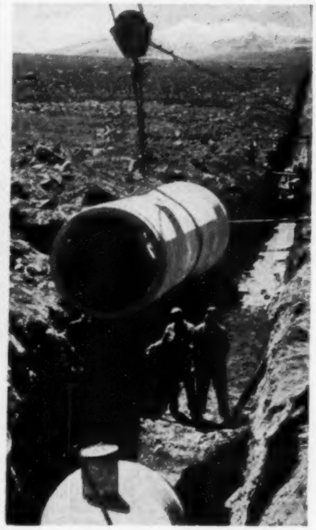

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Apr. 12–14—Kansas Section, at Baker Hotel, Hutchinson. Secretary, Harry W. Badley, Representative, Neptune Meter Co., 119 W. Cloud, Salina.

Apr. 14—California Section, at Biltmore Hotel, Santa Barbara. Secretary, Frank F. Watters, Hydr. Engr., State Public Utilities Com., State Bldg., Civic Center, San Francisco.

Apr. 19–21—Nebraska Section, at Cornhusker Hotel, Lincoln. Secretary, Joseph J. Rossbach, Metropolitan Utilities, 18th & Harney Sts., Omaha.

Apr. 20–22—Arizona Section, at San Marcus Hotel, Chandler. Secretary, A. D. Cox, Jr., Secy. & Comptroller, Arizona Water Co., Box 5347, Phoenix.

Apr. 23–26—Southeastern Section, at Poinsett Hotel, Greenville, S.C. Secretary, N. M. deJarnette, 96 Poplar St., N.W., Atlanta, Ga.

Apr. 26–29—Pacific Northwest Section, at Empress Hotel, Victoria, B.C. Secretary, Fred D. Jones, W. 2108 Maxwell Ave., Spokane, Wash.

Jun. 1–3—Canadian Section, at Prince Edward Hotel, Windsor, Ont. Secretary, A. E. Berry, 72 Grenville St., Toronto, Ont.

Jun. 20–22—Pennsylvania Section, at Galen Hall Hotel, Wernersville. Secretary, L. S. Morgan, County Health Dept., 50 N. Main St., Doylestown.

Jun. 27—New Jersey Section, at North Jersey Country Club, Wayne. Secretary, A. F. Pleibel, Dist. Sales Mgr., R. D. Wood Co., 683 Prospect St., Maplewood.

Fall 1961

Sep. 11–13—Kentucky-Tennessee Sec., Louisville, Ky.

Sep. 13–14—New York Sec., Saranac Lake.

Sep. 13–15—North Central Sec., Minneapolis, Minn.

(*Continued on page 8*)

Coming Meetings

(Continued from page 6)

Sep. 20–22—South Dakota Sec., Rapid City.

Sep. 25–26—Canadian Sec., Maritime Branch, Moncton, N.B.

Sep. 27–29—Wisconsin Sec., Milwaukee.

Sep. 28—Connecticut Sec.

Oct. 1–3—Missouri Sec., Springfield.

Oct. 2–4—Rocky Mountain Sec., Taos, N.M.

Oct. 4–6—Virginia Sec., Roanoke.

Oct. 5–6—Intermountain Sec., Twin Falls, Idaho.

Oct. 8–11—Alabama-Mississippi Sec., Biloxi, Miss.

Oct. 15–18—Southwest Sec., San Antonio, Tex.

Oct. 18–20—Iowa Sec., Cedar Rapids.

Oct. 25–27—California Sec., Sacramento.

Oct. 25–27—Ohio Sec., Toledo.

Oct. 25–28—New Jersey Sec., Atlantic City.

Oct. 29–Nov. 1—Florida Sec., Orlando.

Nov. 1–3—Chesapeake Sec., Baltimore, Md.

Nov. 13–15—North Carolina Sec., Asheville.

OTHER ORGANIZATIONS

1961

May 2–4—16th Annual Industrial Waste Conference, Memorial Center, Purdue Univ., Lafayette, Ind. Write: Don E. Bloodgood, Prof. of San. Eng., Purdue Univ., Lafayette.

May 15–16—Conference on "Water Pollution in the Great Lakes Area," sponsored by DePaul University, at the Pick-Congress Hotel, Chicago, Ill. Write: Lawrence Ragan, Public Relations Dept., DePaul Univ., 25 E. Jackson Blvd., Chicago 4.

May 23–Jun. 1—5th Congress, International Water Supply Assn., Congress Hall, West Berlin, Germany.

Jun. 9–17—13th International Chemical Engineering Exposition and Congress, Frankfurt Am Main, Germany.

Jun. 18–23—AIEE, Ithaca, N.Y.

Jun. 26–Jul. 1—7th Congress, International Committee on Large Dams, Rome, Italy.

Jun. 25–30—ASTM Annual Meeting, Atlantic City, N.J.

SHORT COURSES

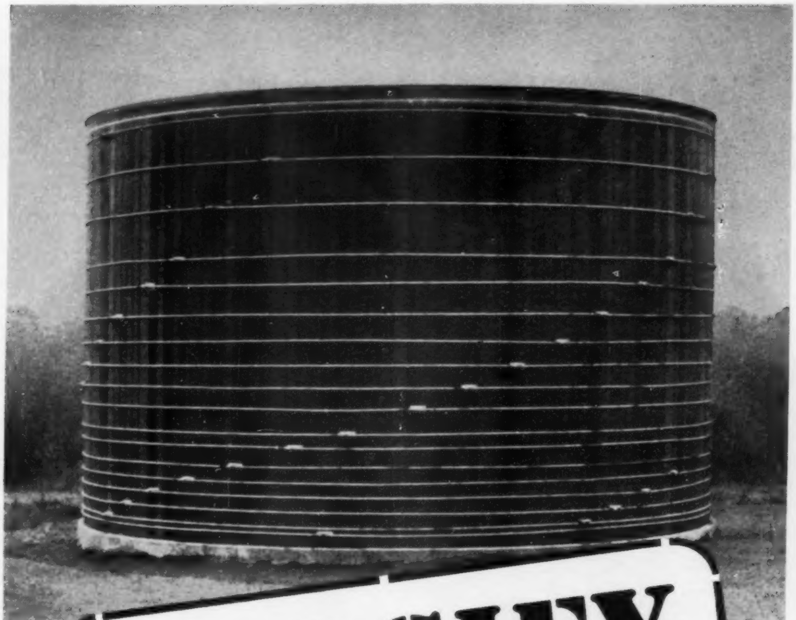
1961

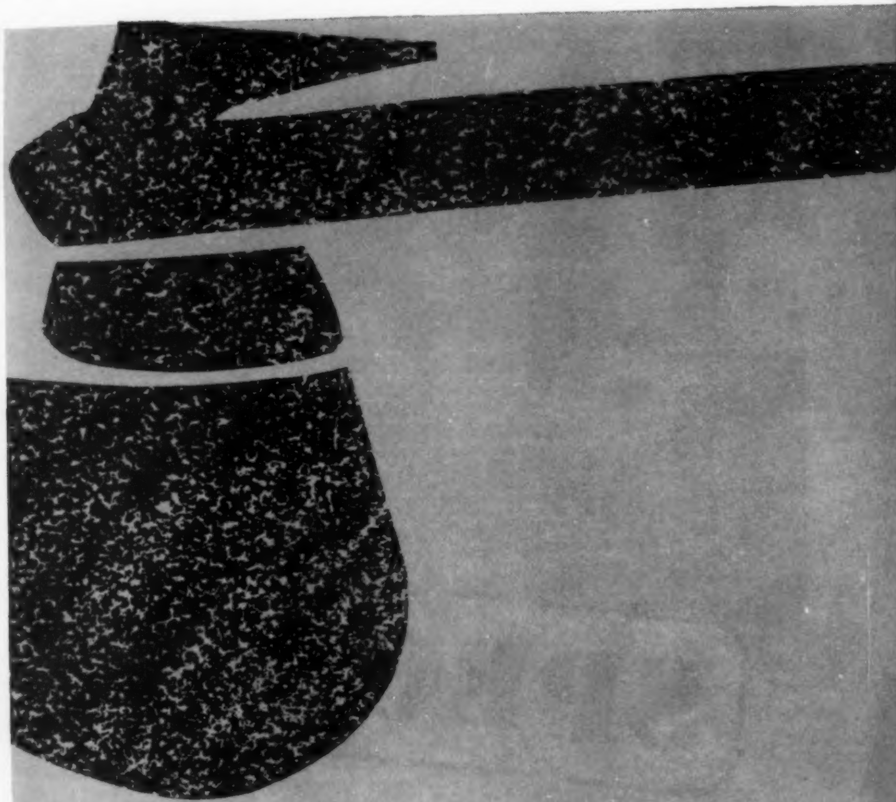
Apr. 23–28—Training course on "Environmental Health Aspects of Health Mobilization," OCDM Staff College, Battle Creek, Mich., sponsored by the USPHS Div. of Health Mobilization. Write: Mrs. Jean M. Nowak, Information Officer. Div. of Health Mobilization, USPHS, Washington 25, D.C.

Jun. 6–8—5th Annual Appalachian Underground Corrosion Short Course, West Virginia University, Morgantown, W.Va. Write: John H. Alm, Rm. 605, 2 Gateway Center, Pittsburgh 22, Pa.

Jun. 19–21—Rudolfs Research Conference, Rutgers University, New Brunswick, N.J. Write: H. Heukelekian, Chairman, Dept. of Sanitation, Rutgers University, New Brunswick, N.J.

Jun. 19–30—Training Course on "Aquatic Biology for Engineers," Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Write: Chief, Training Program, 4676 Columbia Pkwy., Cincinnati 26, Ohio (or to USPHS regional office).

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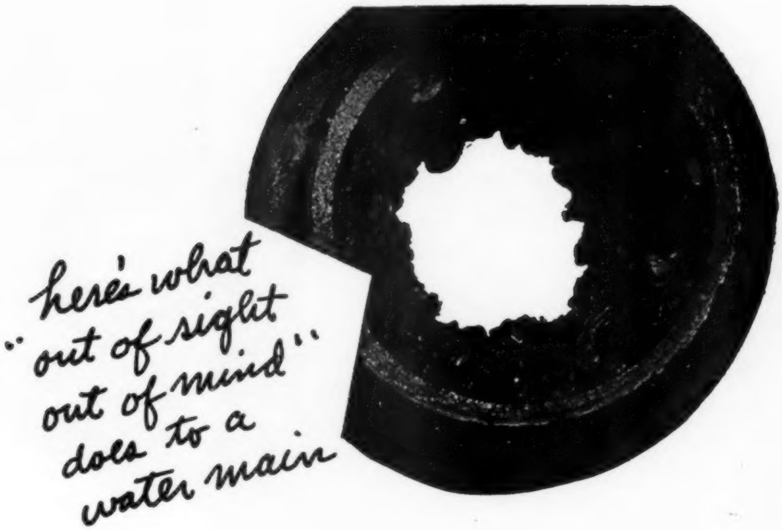
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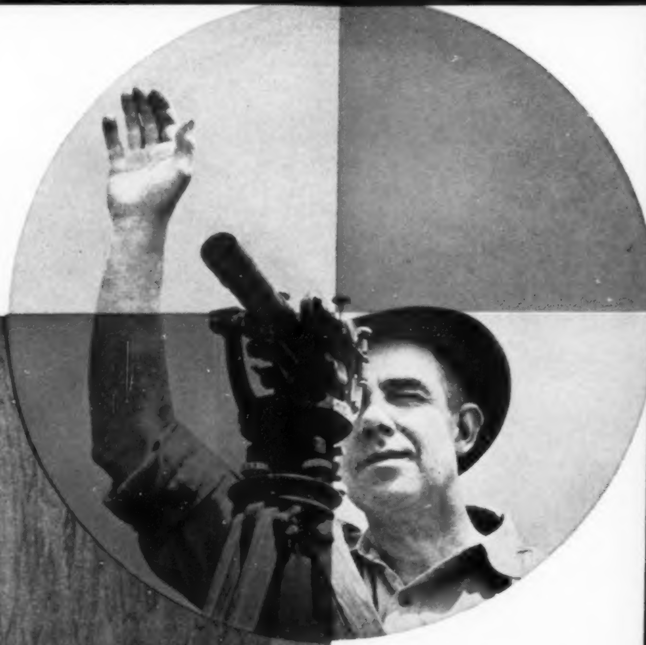

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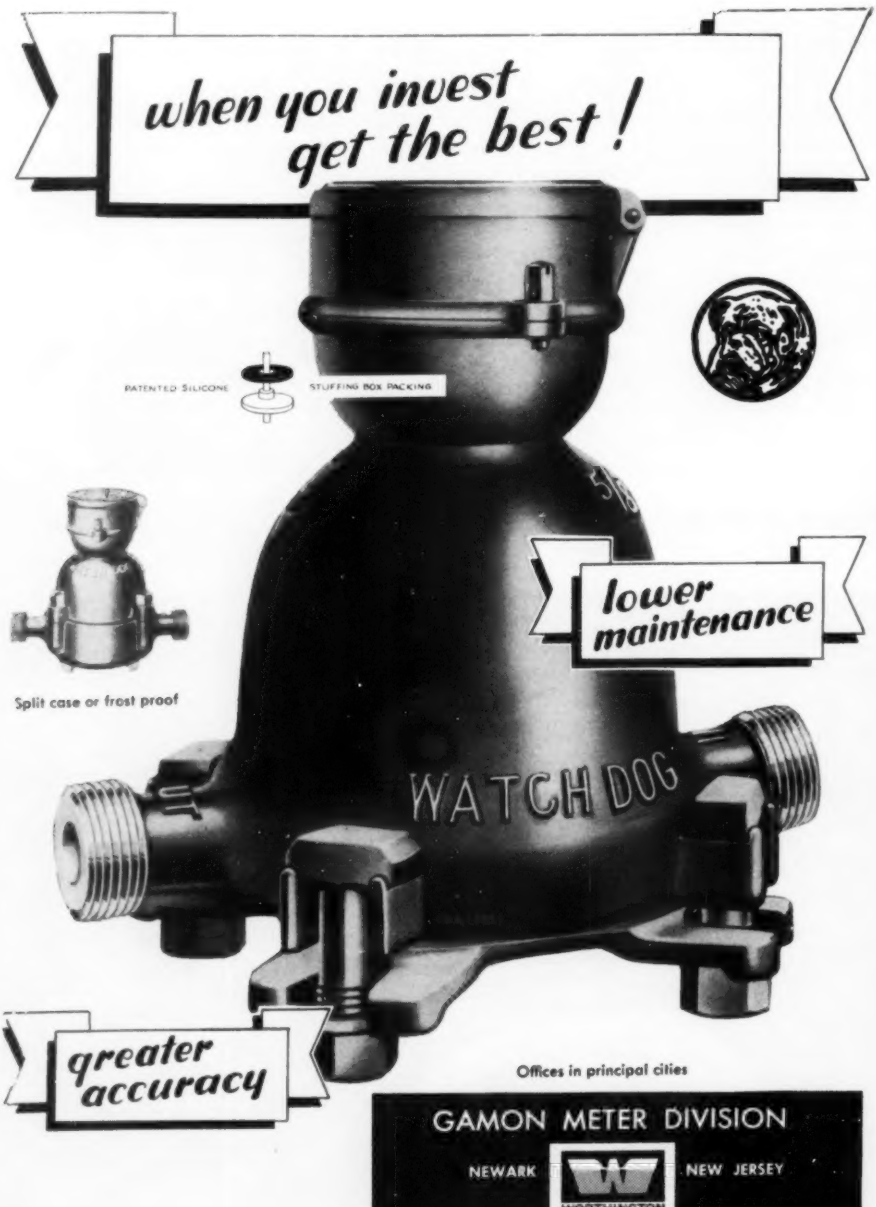
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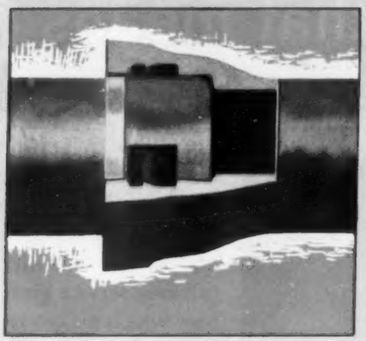

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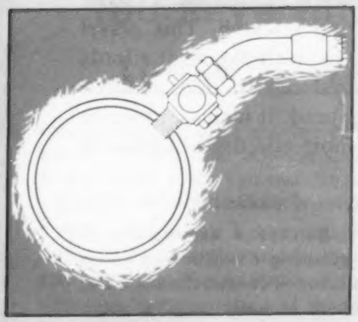

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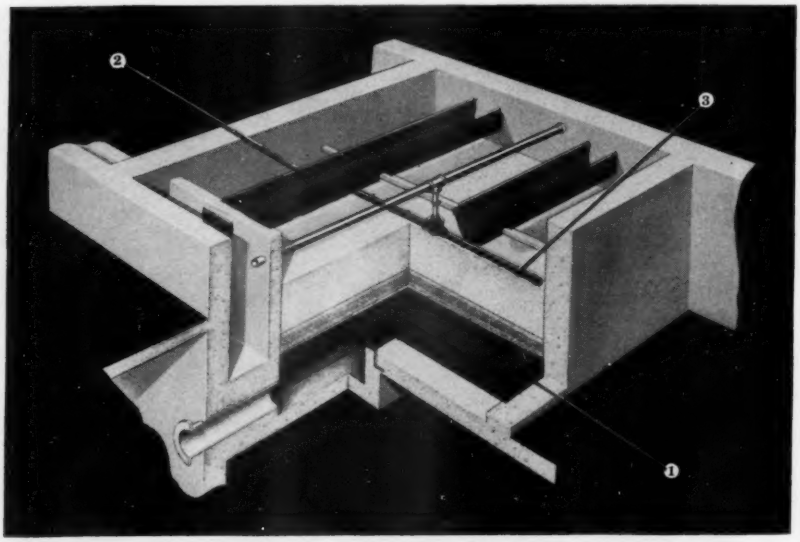
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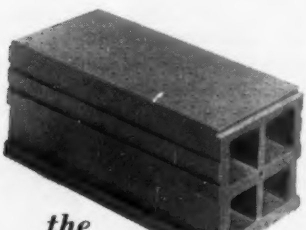

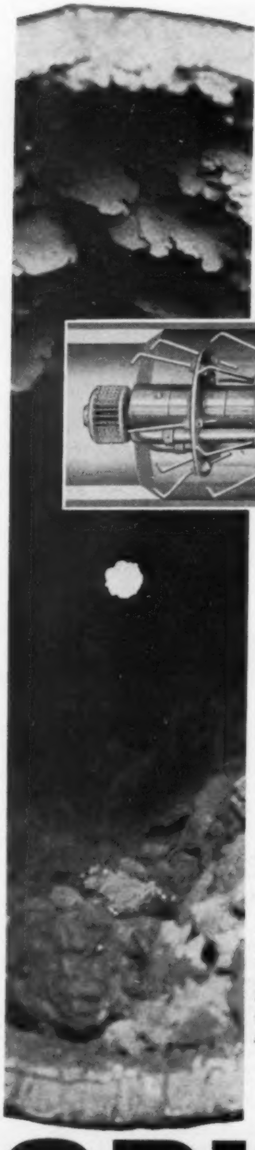

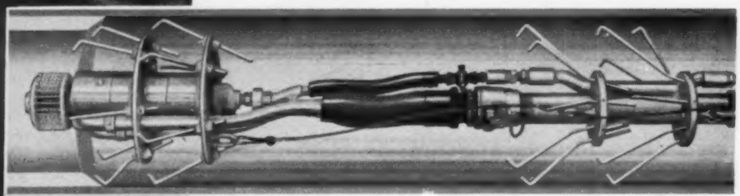

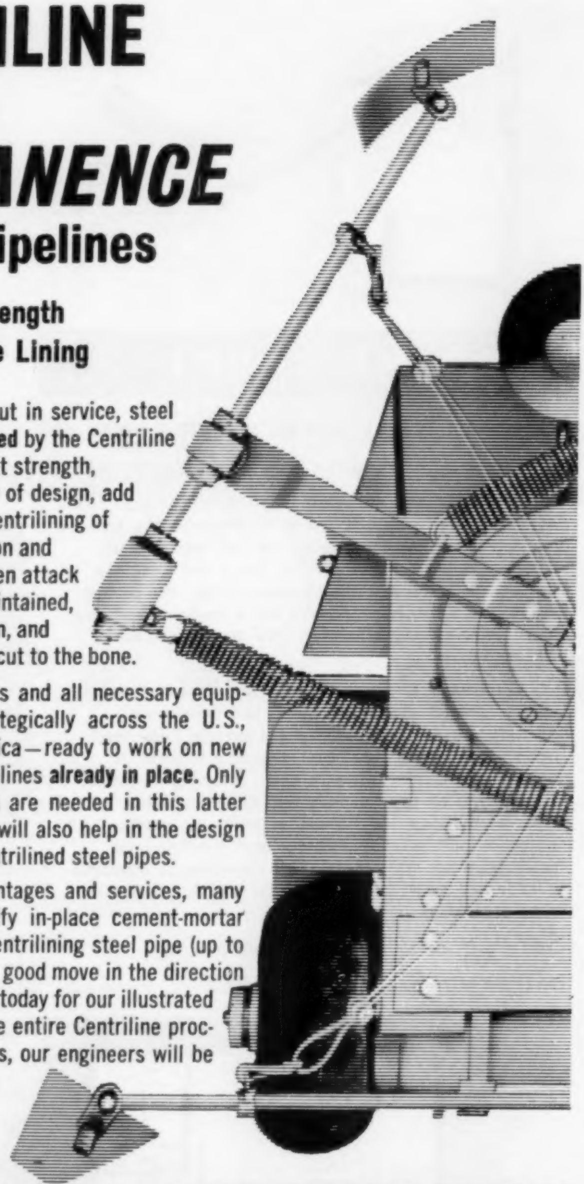

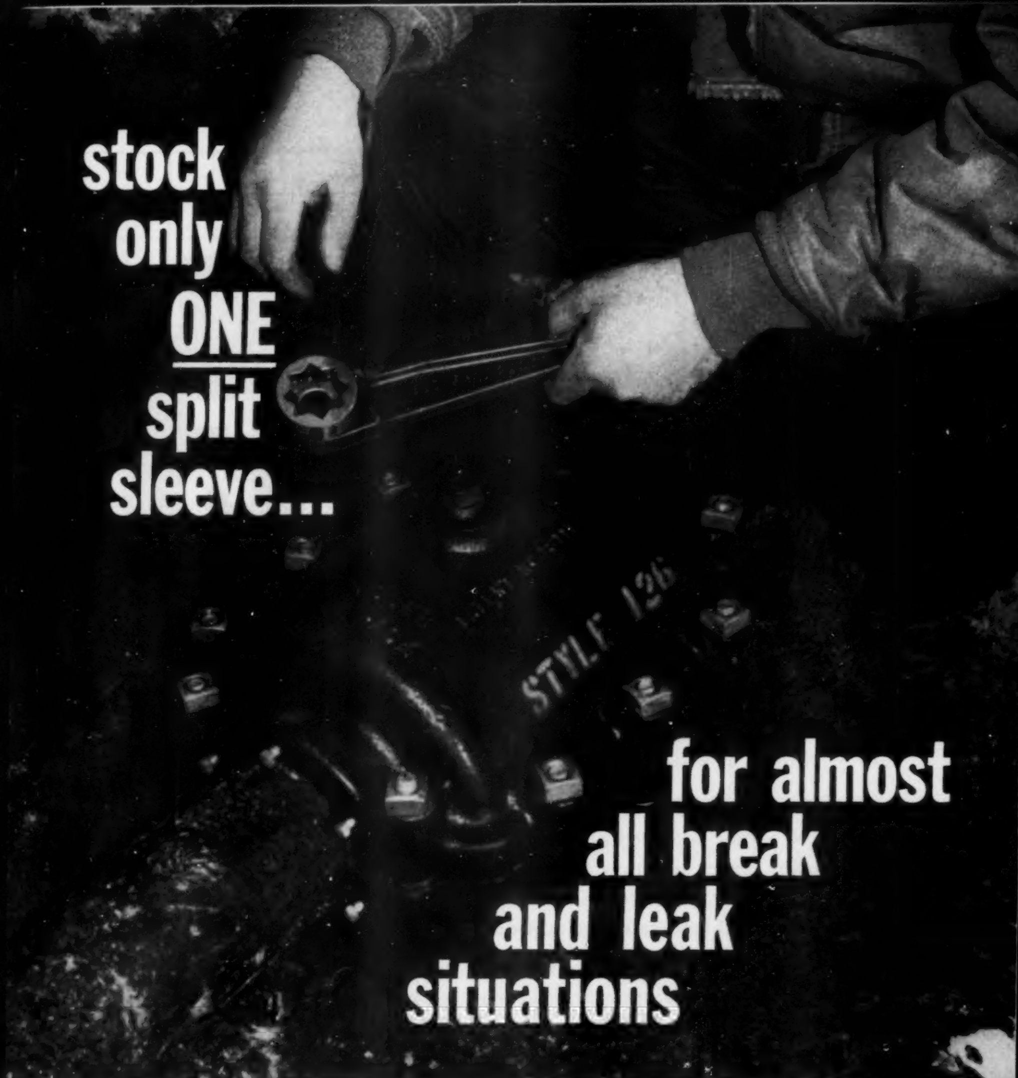

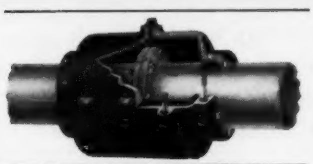

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Journal

AMERICAN WATER WORKS ASSOCIATION

VOL. 53 • APRIL 1961 • NO. 4

Summary Report of Senate Select Committee on National Water Resources

A summary of Report 29 (Jan. 30, 1961) of the Senate Select Committee on National Water Resources, Robert S. Kerr, Chairman, and Thomas H. Kuchel, Vice-Chairman. This summary is Part 1 of the report presented at the first session of the 87th Congress of the United States. The complete report is available from US Govt. Printing Office, Washington, D.C.

A. INTRODUCTION

HUMAN existence depends on water. The pervasiveness of water is revealed dramatically, yet simply, in the initial verses of Genesis' stirring account of the Creation. Science tells us that the earliest forms of life began in the vast oceans of the primeval earth. We know that the human body is more than 70 per cent water. Without water, life as we know it would perish from the earth.

This precious mineral has been a key to man's advancement since before the beginning of recorded history. In addition to personal uses, we need it to grow our crops, to water our stock, to move our heavy cargoes, and to dispose of our wastes. Many manufacturing processes depend on water. It is the universal solvent, the universal coolant. We use it to power our industry. And when our work is done, we find water is essential to much of our recreational activity.

The earliest civilizations were established where water supplies were available. Recorded history began in the valleys of the Tigris and Euphrates, and the Nile. Many historians believe that the decline and disappearance from the face of the earth of ancient civilizations in many of the arid or semiarid regions began with the failure to use their available water resources properly. And today, water is assuming ever increasing importance, as civilization's needs for water and water-related products and services grow. Areas of this globe which will thrive, or even survive, will be determined by

the availability of water resources and their wise use to serve man.

With its abundant supply of good water, and its advanced technology and skills, the United States need never suffer for lack of water. Water shortages can be alleviated. The lack of water need not limit our economic destiny. But positive action must be substituted for complacency. There is work to be done, work to develop and use the abundant resources placed in our custody by a Munificent Providence, work to develop the practices and techniques which will permit ever increasing needs to be filled within the finite limits of the resources we have. *The first and most important step toward getting the job done is the development of increased public awareness and understanding of the nation's water resources problems; of their effects on the nation's economy; and of the possible ways of solving them.* Facilitating this step has been one of the primary objectives of the Select Committee on National Water Resources.

The committee has traveled the length and breadth of the nation to hold hearings; it has heard the statements of hundreds of witnesses and made them widely available through printed copies of the transcripts. The views of the governors of the 50 states with respect to their water problems have been obtained and published. Informational reports have been prepared on all aspects of water resources activities, and copies have been given widespread distribution. The committee is of the opinion that the findings and recommendations of this report should likewise be made widely available as a stimulant to public action, and urges that many copies of the report be printed for public distribution.

The water resources development job facing this nation in the years ahead to 1980, and beyond, is of tremendous magnitude and complexity. Far more public understanding and support for the necessary programs will be needed than has been obtained in the past. It is essential that there be created a public sense of high purpose and responsibility for future governmental action in this field. Recognition must be given to the human values involved, as well as to the economic values. There must be well organized public participation in the necessary activities in order that human needs can be met. The committee would emphasize the importance of planning the nation's water development in terms of producing the most jobs at the highest income levels, while at the same time taking full advantage of the nonrevenue purposes associated with water development, so that their capacity for improving the quality of life for the people of this country can be fully used.

It may be well to recognize also that in our water resources programs there is an opportunity for improvement of our relations with the underdeveloped nations of the world. The development of water resources is of strategic importance in nearly every country possessing unused resources and having ambitions to secure a higher standard of living for its people. We have used our water resources knowledge as an effective instrument of foreign policy in some areas, through the wide-ranging activities of our federal agencies and our private consulting firms, which have exported American technological discoveries in the water resources field to the far corners of the earth. Our Tennessee Valley

Authority has attracted widespread public interest as an example of what could be done in the direction of integrated development of water resources. If we wish to maintain the favored position we have had in international relationships, we may profit from an examination of ways in which the more advanced water resources techniques not only can enable us to meet our own needs but can be made available abroad as important instruments of our foreign policy. The better the scientific basis for our techniques, and the more extensive our domestic experience with them, the more successful application abroad is likely to be. Here is an excellent opportunity for our nation to demonstrate before the world its ability to harness its resources in basic public works of peaceful intent.

In this summary report, the committee reviews the principal findings of its studies, and presents its conclusions as to the nature of the task which faces the nation in the years ahead. The committee recommendations that follow look toward: (1) better comprehensive planning for optimum development of our water resources, with improved coordination of federal, state, and local activities; (2) strengthening state participation in the planning and decision-making process; (3) improving research programs in areas in which there are deficiencies in our knowledge, with emphasis on those in which progress is most needed; (4) a periodic assessment of the water supply-demand situation; (5) better use of flood plains; (6) further study of areas in which the problems are most severe; (7) a study of the problems involved in future reservoir construction; and (8) more intensive use of public hearings as a means of stimulating public interest in water resources development and insuring that all views are considered.

B. NATURE OF THE NATIONAL WATER PROBLEM

Water problems are found in all parts of the United States. They are becoming more acute and widespread as the demands of our growing population, agriculture, and industry press ever nearer to the potential limits of the supply of water that nature provides. The major problems may be classified as falling within one of six categories: supply, distribution, natural quality, manmade pollution, variability, and floods; and they are dealt with in that order in this summary of the findings of the committee's studies.

1. Water Supply in Relation to Demand

Reports submitted to the committee indicate, based on medium projections of population increase, that by 1980 demands on the nation's water resources will almost double, and they will triple by the year 2000. Projections of all these demands have been put together for the committee in the form of regional water supply-demand studies for all regions of the United States except Alaska and Hawaii, which have water supplies and problems which are physically independent of those of the contiguous states.

In general, the projections are based on assumptions that the nation's economy will continue to grow at the same rate as it has in the past, that adequate water supplies will be made available under the present general pricing policies, that there will be relatively little change in presently known technical methods of water use, and that, with

the exception of increased application of techniques for improving the efficiency of irrigation, present inefficient methods of using water will continue.

An increase of more than 7,000,000 acres of irrigated land from 1954 to 1980 is projected, but increases in costs and absolute shortages of water are expected to bring about overall improvements in efficiency, by the use of presently known techniques, which will hold down the total amount of water used for irrigation to the extent indicated. Some of the other assumptions used in the supply-demand studies are that soil and water conservation practices on agricultural and forest lands are expected to increase considerably, as projected by the Department of Agriculture, and that increasing demands for fish and wildlife will be met by an increase in acreage of swamps and wetlands for wildlife habitat, and an increase in water quality for fish life. Recreation based on water is projected to increase manifold. This is expected to be accomplished partly by more intensive use of the same water

TABLE 1

Total Requirements for Withdrawals and Consumptive Uses or Depletions From Streamflow

Purpose	1954*		1980		2000	
	Gross Withdrawals *bgd*	Net Consumptive Uses or Depletions From Streamflow *bgd*	Gross Withdrawals *bgd*	Net Consumptive Uses or Depletions From Streamflow *bgd*	Gross Withdrawals *bgd*	Net Consumptive Uses or Depletions From Streamflow *bgd*
Diversions						
Irrigation	176.1	103.9	167	104.5	184.5	126.3
Municipal	16.7	2.1	28.6	3.7	42.2	5.5
Manufacturing	31.9	2.8	101.6	8.7	229.2	20.8
Mining	1.5	0.3	2.7	0.6	3.4	0.7
Steam electric-power cooling	74.1	0.4	258.9	1.7	429.4	2.9
Subtotal, withdrawals and consumptive uses	300.3	109.5	558.9	119.3	888.4	156.3
Onsite uses						
Watershed improvement programs				4.0†		7.0†
Swamps and wetlands for wildlife‡				66.7†		89.9†
Subtotal, onsite depletions				70.7		96.0
Total of consumptive uses and depletions				190.0		253.2

* The year 1954 was used as the base year for the supply-demand studies because it was the last year for which statistics on water use had been compiled.
† Increase over 1954 depletions for these purposes.
‡ Includes also other depletions for fish and wildlife, such as consumptive use of water by fish hatcheries.

areas used at present, and partly by the new reservoirs which will be required for storage of water. Furthermore, the pollution control measures that the studies indicate are essential and will greatly enhance the recreation potential of the nation's waters.

In presenting the results of the study which is based on the aforementioned assumptions by the committee staff and the participating agencies, the committee does not mean to imply that it is predicting that these assumptions will be adopted as a matter of national policy, that it is recommending their adoption, or that it is endorsing the specific rates of growth on which the study is based. The committee hopes that the nation's growth rate will be greater, in which case the projections of water use in 1980 and 2000 will be attained some years earlier than the study would indicate. The committee emphasizes the need for prompt and affirmative action in the field of water resources to prevent lack of water from inhibiting our national growth.

The committee's water supply-demand study projects and demands for withdrawals, consumptive uses, and depletions of water for various purposes are shown in Table 1. Water resource regions in the United States are shown in Fig. 1.

As of 1954, the average remaining streamflow in the United States, exclusive of Alaska and Hawaii, was about 1,100 bgd.* Demands for withdrawals of 300 bgd were thus about equal to 27 per cent of streamflow in 1954. This figure is substantially higher than published estimates of the US Geological Survey for 1955, as it is computed on the assumption that the optimum amounts of water for irrigation are made available to the growing plants, whereas, in actuality, substantial shortages were felt in 1954. Demands are projected to increase to 559 bgd or 51 per cent of streamflow by 1980, and to 888 bgd or 81 per cent of streamflow by the year 2000. At first glance, the projected demand appears to approach frighteningly near the limit of the nation's available water supply, and it will be necessary to expand vigorously programs for water resources development if this demand is to be met. It must be remembered, however, that these are withdrawals, and that, necessary as it may be to provide for them, most of this water is returned to the stream and can be reused many times, provided steps are taken to maintain its quality.

Consumptive uses, or losses, for the various purposes range from about 60 per cent of water withdrawn for irrigation down to a fraction of 1 per cent of water diverted for steam-electric-power cooling, which, under present methods of use, would require the largest withdrawals of water before 1980. As shown in Table 1, the supply-demand studies project consumptive uses increasing 109.5 bgd in 1954, to 119.3 bgd by 1980, and 156.3 bgd by the year 2000. Projected consumptive uses of water diverted from streams or underground sources thus range from an amount less than 10 per cent of streamflow in 1954, to 11 per cent in 1980, and about 14 per cent in the year 2000.

In addition to the foregoing losses of water to the atmosphere, conservation practices for watershed improvement may result in increases in evaporation,

* On an annual basis, the nation's streamflow has ranged from 50 per cent of the average during periods of drought, such as during the 1930's, to nearly 140 per cent of average during periods of excess precipitation.

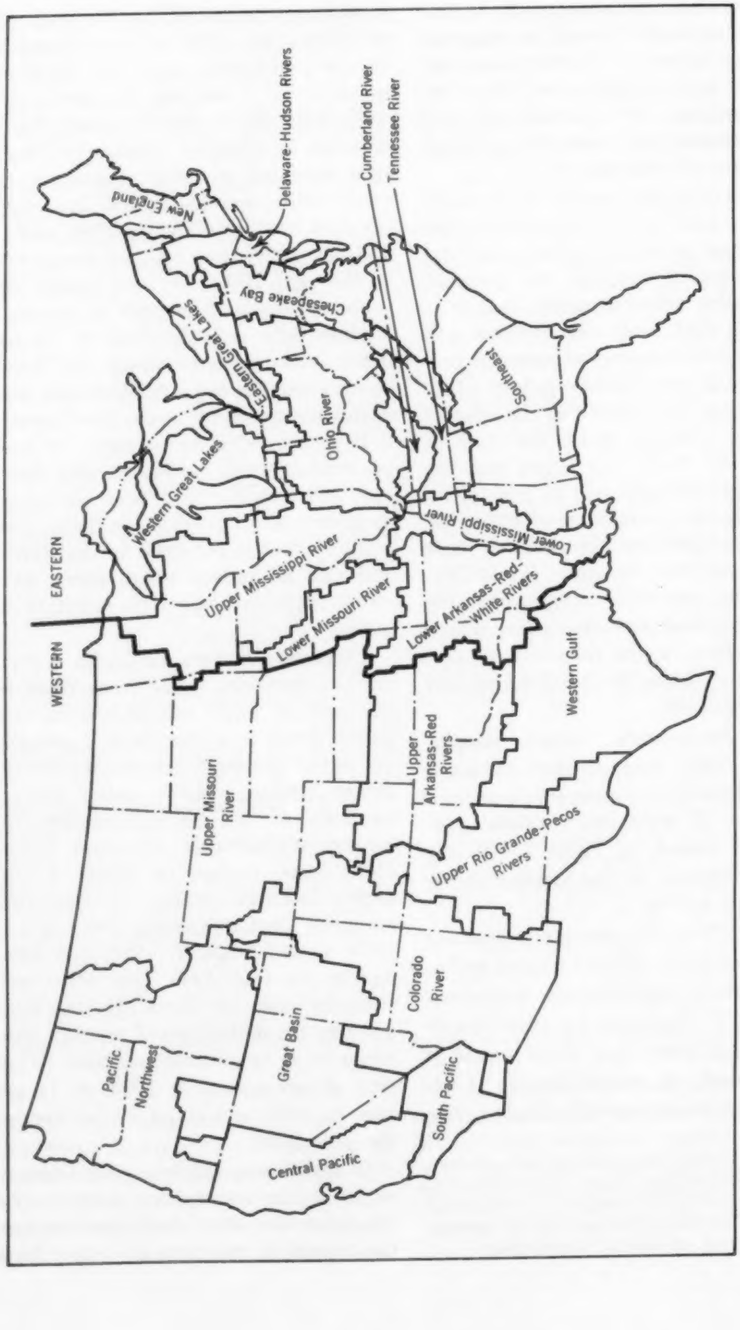

Fig. 1. Water Resources Regions

For purposes of the study, the United States was divided into 22 water resource regions.

primarily from the surfaces of small reservoirs, and maintenance of increased amounts of swamps and wetlands for production of wildlife would increase evaporation and transpiration losses. Projected increases in depletion from streamflow resulting from these onsite uses are shown in Table 1. No figures are shown for 1954 depletions, because natural depletions for these purposes are already reflected in the 1,100-bgd estimate of remaining streamflow. The total of consumptive uses and depletions is thus projected to be 190 bgd, or about 17 per cent of available streamflow in 1980, and 253.2 bgd, or about 23 per cent in the year 2000. The relationship of withdrawals and consumptive uses and depletions for various purposes and in total is shown in Fig. 2.

In addition to water to provide for consumptive uses or depletions, tremendous quantities of water are needed in our flowing streams for hydroelectric-power production, navigation, recreation, fish habitat, and pollution abatement. Estimates of flow requirements for these purposes have been developed by the committee's studies, with the exception that no estimates have been made of amounts of flowing water needed for water-based recreation. In the supply-demand studies, it is assumed that if water requirements for navigation are met, and if water of adequate quality for fish life is maintained, the needs of recreation will be met.

With respect to pollution abatement, the most effective means is by treatment of sewage to remove wastes or to reduce them to inoffensive, harmless substances. Even with almost complete treatment of wastes, however, adequate streamflows are required for dilution of the effluent from the treatment plants. By almost any reasonable standard of measurement, an inadequate job of pollution abatement is being performed on the nation's rivers. It is estimated as of 1954 that only 44 per cent of the pollutants were being removed from municipal sewage and an even smaller percentage from industrial wastes; the remaining pollution, except for that disposed of directly to the oceans or other large bodies of water, was being disposed of into rivers. The odoriferous and offensive condition of many of the nation's streams and rivers bears witness to the fact that insufficient water for dilution of this quantity of waste material was available in 1954, a condition which exists to the present time in many of our rivers.

TABLE 2

Streamflow Uses

Uses	1954	1980	2000
Hydroelectric power	374.0	616.0	636.5
Navigation	281.0	238.4	221.4
Sport fish habitat	78.0	171.0	241.4
Dilution for pollution abatement		332.2	446.5

For the purpose of the studies, it was assumed that a reasonably adequate quality of water would be water containing sufficient oxygen to support fish life, generally believed to be a dissolved oxygen content averaging 4 mg/l; or about 4 parts oxygen per 1,000,000 parts of water.

With the foregoing assumptions taken into account, needs for the quantities of water flowing in the nation's streams are shown in Table 2. No value is shown for dilution requirement for pollution abatement in 1954, because no such requirement or specifi-

cation existed at that time, or, for that matter, at the present time.

The quantities of water needed for pollution abatement in 1980 and 2000 are projected on the basis that the desired quality of water in rivers will be achieved by the cheapest combination of waste treatment facilities and storage to provide sustained flows for dilution of effluent. For many reasons,

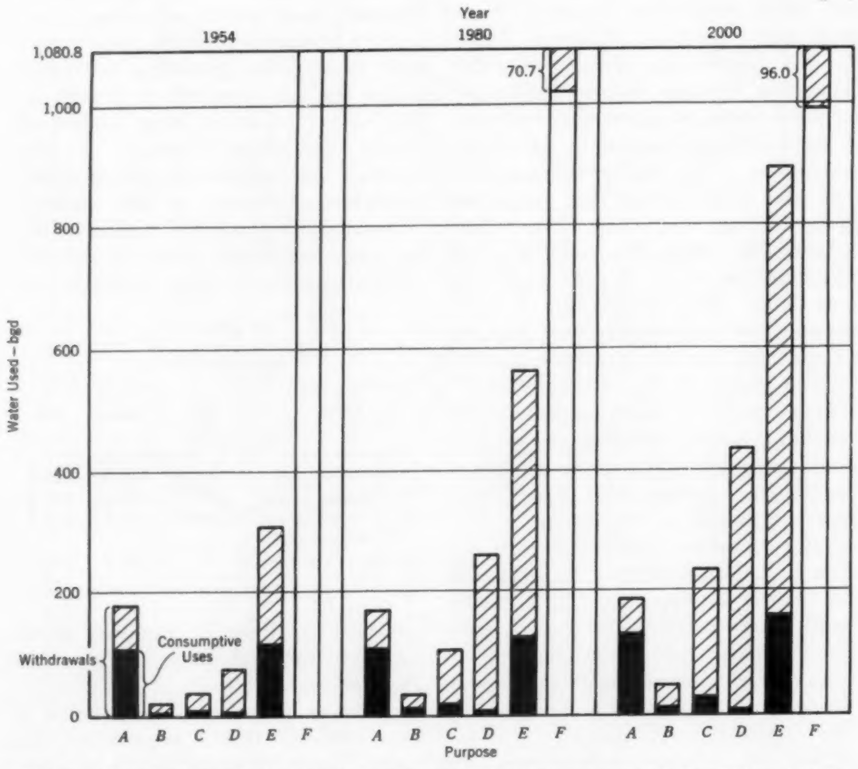

Fig. 2. Water Withdrawals and Consumptive Uses: Diversions and Depletions From Streams and Other Sources

The letters represent: A, irrigation; B, municipal use; C, industrial use; D, steam-electric-power cooling; E, total withdrawals and consumptive uses; and F, water supply available. Except for the quantities consumed, the same water can be withdrawn and reused many times, provided its quality is maintained. The value 1,080.8 bgd on the ordinate is the average flow that can be sustained under 1954 conditions. This is the maximum low flow before depletion from use but after estimated evaporation losses from added reservoir capacity. The bracketed portion of the "water supply available" bars for the years 1980 and 2000 represents the increase after 1954 in onsite depletions by additional swamps and wetlands for fish and wildlife and by watershed improvement programs. Onsite depletions are not shown for 1954 because they have already been subtracted from average flow.

this combination will vary from region to region, but the degree of waste treatment can generally be expected to range upward from 70 per cent treatment in 1980 and 80 per cent treatment in the year 2000, reaching 90–95 per cent or even higher in water-short regions, or where costs of storage reservoirs are high. Streamflow uses are shown in Fig. 3.

With the degree of river regulation that will be needed to provide for the nation's water needs in 1980 and 2000, there will be many opportunities for development of hydroelectric power. As there are alternative sources of producing electric power, however, the quantities of water needed for pollution abatement were assumed to be controlling. When added to the consumptive uses and depletions tabulated earlier, nationwide total streamflow requirements are: total losses plus flows required for pollution abatement, 522.2 bgd in 1980; 699.7 bgd in 2000. The minimum flow requirements estimated for 1980 and 2000, indicating that the nation would be using 49 per cent of its total water resources in 1980 and 63 per cent in 2000, appear to be well within the total supplies available. It would be possible for increases in water use in the year 2000 to be up to about 50 per cent over those assumed if streamflow could be fully regulated. The task of meeting projected water needs will make it necessary to increase considerably the rate of construction of water storage and sewage treatment facilities.

2. Problems of Distribution

The nation's water resources are not uniformly distributed in all the geographic regions. There are already substantial areas of water shortage in many of the river basins in the western half of the United States. On the basis of the water supply-demand studies prepared under the foregoing assumptions, full development of all of the available water resources in 5 of the 22 water resource regions (Fig. 1) into which the contiguous part of the United States was divided for the purposes of the studies will be required by 1980 or earlier, if the projected increases in population and economic activity are to be achieved. These five regions are:

1. South Pacific *
2. Colorado River
3. Great Basin
4. Upper Rio Grande–Pecos River
5. Upper Missouri River.

By the year 2000, the following regions will be added to the list of those in which full development of available water resources will be required if the projected demands are to be met:

6. Upper Arkansas–Red rivers
7. Western Great Lakes †
8. Western Gulf.

These findings, of course, should not be construed as placing a ceiling upon the growth of population and economic activity in the water-short regions. The technical, legal, financial, and political problems involved in meeting future water needs in these regions are considerable, but the national interest demands their solution. Furthermore, the committee's studies indicate that the means for solving these problems

* It might be said that this region has already run out of water. Present deficiencies are being met by importation of water from other regions, and plans are being made for additional importation from the Central Pacific Region.

† This is a special case, assuming availability only of runoff from the United States portion of watershed and not considering additional use of Great Lakes water for waste dilution.

are certainly available. If bold programs for the construction of storage reservoirs, reclamation projects, flood control facilities, and other works which have been conceived by the agencies involved are carried out, and if the new techniques for desalting, evaporation control, and waste disposal now developed or being developed are applied, adequate water, both in quality and quantity, will be available. If we add to these programs the possibility that underground aquifers may be used for additional storage and that neces-

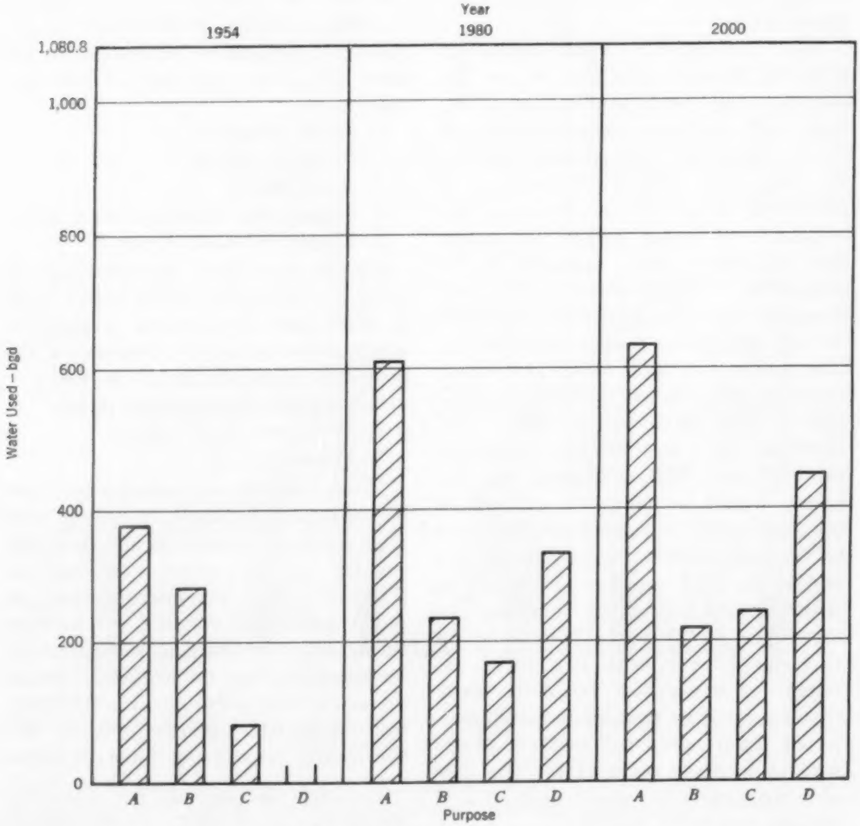

Fig. 3. Streamflow Uses

The letters represent: A, *hydroelectric power;* B, *navigation;* C, *sport fish habitat; and* D, *pollution abatement. The value 1,080.8 bgd on the ordinate represents the average flow that can be sustained under 1954 conditions. This is the maximum low flow before depletion from use but after estimated evaporation losses from added reservoir capacity. No amount has been shown for 1954 pollution abatement, because there were no standards for that year.*

sary interbasin transfers can be worked out, it will be seen that vigorous all-out water resource development will enable the water-short areas to play their full part in the future development of the national economy.

It should be kept in mind that the water resource regions used in the study embrace a wide range of runoff conditions. A more detailed study of supply-demand relationships would show that some portions of the regions listed are already deficient in water supply or quality to meet present needs, while in other portions, there may be sufficient water supplies to meet all projected needs through the year 2000.

3. Water Quality Problems

Supplies of natural water are extremely variable in quality, thus creating problems where water of inadequate quality for man's use is available. Impurities which must be removed before poor quality waters may be used include sediments or materials in suspension which can be removed by settling, filtration, or other mechanical means, and salts and other impurities which are dissolved or chemically combined into the water. Costs of treatment to remove impurities vary with the degree of purity required. For many purposes it is possible to use water of relatively low quality, and this has been done frequently in the past. Also, at many times it has been cheaper or simpler to go long distances to obtain water of higher quality than to develop and use waters of poor quality.

As demands for water increase in relation to supplies, it may be found necessary to use water of poor quality. Removal of sediments and materials in suspension presents no great problem. Removal of salts and other minerals found in natural waters can be accomplished with techniques now known, but at relatively high cost. There is need for improving known techniques or developing new ones which will permit desalting or demineralization to be accomplished at lower cost. This will aid in solving problems in some of the water-short areas, by permitting new supplies of brackish ground waters to be utilized.

Mention must also be made of the possibilities for keeping impurities out of the water. Techniques for finding and sealing salt springs are being developed, and show some promise of increasing the usefulness of some streams now of substandard quality. Likewise, land treatment programs for holding back sediments from our rivers are of value in improving water quality and lessening costs of removing impurities.

4. Pollution Problems

Manmade pollution likewise creates severe problems, some of which are related closely to, and compound the problems of, inadequate natural quality of water. Many types of waste materials are disposed of in rivers, because there is no other convenient place to dispose of them. There are many categories of wastes, some of which can be dealt with entirely by treatment, and others which require dilution to render them inoffensive or harmless. The principal categories considered for the purposes of this analysis are: (1) sewage and other wastes which demand oxygen as they decompose, and which may include disease-producing infectious agents; (2) inert materials containing phosphorus and nitrogen, which result from biological reduction of sewage and serve as plant nutrients; and (3) chemicals, including radio-

active substances. In addition, man-made pollutants include sediments and heat, which may intensify the problems caused by the former three major categories of pollution.

Improvements in methods for dealing with pollution have not been extensive in the past several decades. Also, the nation has lagged in building facilities for pollution abatement making use of the techniques that are known. Progress has been made in cleaning up some streams, but the backlog of needs is still very large. As the demand for water grows, and as more widespread reuse of water becomes necessary, it will be essential for a great deal more progress to be made in the construction of sewage and industrial waste treatment works and in regulation of the flow of rivers, so that adequate quantities of dilution water will be available during periods of low flow. Furthermore, research and development of new techniques and processes for treatment of wastes are needed in two directions—first, to permit reduction in the costs of the pollution abatement job, and, second, to develop techniques for dealing with some of the newer and more unusual types of wastes which cannot be handled by existing methods of treatment.

5. Variability Problems

Even though the average water supply in an area or region may be adequate to meet average demands, variability of supply is a major problem, because demands exceed the supply available at certain times. As noted earlier, annual variations in supply for the country as a whole range from 50 per cent of the average to 140 per cent. There are far greater variations on a regional or seasonal basis. The solution to the variability problem lies, of course, in storing water available in times of excess precipitation and runoff, for use at times when demands exceed runoff, or in adjusting water use to occasional dry periods. Surface reservoirs provide the most obvious solution, but the fact must not be overlooked that nature has provided underground storage reservoirs of great capacity, which achieve the same purpose. If means can be developed for recharging and increasing the yield of underground aquifers, there is an opportunity for great savings in losses from evaporation from surface reservoirs. A number of experiments are being performed looking to finding economic methods for recharging ground water, and the use of nuclear explosives to alter underground formations has been suggested as a way to increase the capacity and usefulness of aquifers in storing water.

6. Flood Problems

The upper extreme of variability problems are those caused by floods. Problems due to floods are brought about by man's encroachment on the flood plains which nature has provided to carry flows in excess of bankfull capacity of streams. Flood damages have been increasing in recent years, not just because of greater floods but because of increasing development of flood plains, which has kept ahead of programs for construction of works to control floods and prevent flood damages. Flood control has been one of the primary fields of federal water resources activity since 1936, and a large part of the nation's multiple-purpose water resources development has been accomplished under the flood control program. As more reservoir storage is constructed to conserve flood flows as a means of increasing low flows to

provide water supplies for all purposes, it is likely that flood problems may be eased and damages decreased. But reservoir storage and flood protective works will need to be supplemented by flood-warning systems, regulation of the use of flood plains, and other measures, in order to secure the most economical solution of flood problems in the public interest.

7. Summary

The foregoing summarization of the situation with respect to the nation's water resources indicates that serious problems lie ahead. Adequate measures must be adopted to deal with situations that can now be foreseen to make sure that shortages of water will not control the future destiny of the nation. The provision and management of water supplies for waste dilution, irrigation of arid lands, outdoor recreation, and the conservation of fish and wildlife appear to pose the most serious water problems, for the following interrelated reasons:

1. Even when advanced practices for waste treatment are applied, large quantities of water are needed for waste dilution, if quality standards are to be maintained which safeguard domestic supplies and permit use of lakes and streams for outdoor recreation purposes and for fisheries.
2. An important sector of the economy of the western states is dependent upon irrigation agriculture. If prospective demands for water for population and industry cannot be met in other ways, attempts may be made to transfer water now devoted to irrigation to municipal and industrial purposes.
3. It has been estimated that a tenfold increase in outdoor recreation demands can be expected by the year 2000. Much of this increase will involve use of water areas. Therefore, recreation will have to be a major consideration in future water resources planning.
4. Part of the outdoor recreation increase is based on fishing and hunting. If this is to continue to grow, large amounts of water will be required for the maintenance of wetlands, and our streams and lakes must be kept of acceptable quality to serve as fish habitat.
5. Although of the highest priority, water demands for direct municipal use are relatively small in comparison with other uses, even when the increasing trend toward urbanization is taken into consideration.
6. Industrial use of water will continue to grow at a very high rate; however, industry is capable of adjusting to considerably smaller supplies through water conservation practices. The major problem will be that of handling industrial-waste disposal satisfactorily.

C. CONCLUSIONS

The task confronting the nation in the water field is one of meeting the growing demands on water resources in the most efficient manner consistent with accepted public aims. It is important that plans be made to meet demands before they arise, so as to avoid any retardation of economic activity in particular localities because of a deficiency in water development. The problem is a dynamic one, because the rapid advances of science continually stimulate new demands and, at the same time, open up new opportunities for meeting them. As government has of necessity assumed major responsibilities in many fields of water development and management, it must equip

itself through the adoption of programs and policies to deal with this dynamic situation.

Generally speaking, there appear to be five major categories of effort needed in the future for meeting prospective demands on a long-range basis so as not to inhibit national or regional economic growth. These are:

1. Regulating streamflow through the construction of surface reservoirs and watershed management
2. Improving the quality of our streams through more adequate pollution abatement programs
3. Making better use of underground storage
4. Increasing the efficiency with which water is used through elimination of wasteful practices, improved sewage treatment methods, recirculation, increased irrigation efficiency, and substitution of air for water cooling
5. Increasing the natural water yield by desalting, weather modification, and other artificial means.

The minimum-cost program developed by the supply-demand studies for dealing with the water supply and pollution abatement problem indicates the need for 315,000,000 acre-ft of reservoir capacity for river regulation by 1980, and an additional 127,000,000 acre-ft between 1980 and 2000. This is in addition to the storage available in 1954, the beginning years of the studies. These amounts of reservoir storage capacity are estimated to require new capital investments of 12 billion dollars by 1980, and an additional 6 billion dollars, for a total of 18 billion dollars by the year 2000. Municipal and industrial sewage treatment works under the same program, which calls for water of relatively high quality in all the nation's streams, would require new investments estimated at 42.2 billion dollars by 1980, and an additional 39.4 billion dollars between 1980 and 2000, for a total of 81.6 billion dollars between 1954 and 2000.

As large as these sums are, they seem modest when related to the expected growth of the gross national product,* which, at the medium growth rate assumed for the supply-demand studies, would increase at a rate of about 3.75 per cent annually, reaching 1,060 billion dollars at constant 1959 price levels in 1980, and 2,200 billion dollars in the year 2000. The growth of the national economy may very well increase at a faster rate, in which case large amounts of water will undoubtedly be needed, requiring even larger investments. It seems clear that as the nation grows, larger and larger amounts can be made available for construction of water facilities without detriment to the economy.

To the extent that development and increased use of underground storage can be achieved, there may be some reduction in the amounts of surface reservoir storage space needed to supply direct water uses, but the bulk of the storage is needed for pollution abatement. It must be emphasized, however, that for the water-short western regions identified earlier, the regulation of streamflow and the utilization of underground storage and groundwater flows will not by themselves be adequate to meet assumed demands. Likewise, in view of the fairly intensive development of much of the East, major conflicts between use of land for storage of water in reservoirs and other land uses can be anticipated. Therefore, if future demands are to be met at minimum cost, it is essential that every effort be made to develop meas-

* The gross national product represents the total national output of all goods and services produced in the United States, valued at current market prices.

ures other than storage to insure that water needs are met.

As is true of many other aspects of modern life, water resources development and management are becoming ever more complex. Science and technology are playing an important part, and are capable of playing an even larger role in meeting future demands upon our water resources. A number of methods of improving our ability to meet these demands are already known, but are not always put into effect. Many of the effective water-saving practices already known will not be adopted as long as large supplies of very cheap water continue to be insured by public agencies.

Research and basic data collection programs already underway are leading toward better management and new methods of dealing with emerging water problems, and the continued support for, and expansion of, these programs by the Congress is essential. Without question, the number, complexity, and difficulty of the decisions confronting the Congress and public officials concerned with water development and management will multiply as the range of choice of alternative methods for dealing with water problems becomes broader. Whatever alternative solutions may be made available by continuing research and data collection, it is clear that many problems are well enough defined, and the means for solution sufficiently known, to permit Congress to vigorously continue and expand programs of water resources development.

The magnitude of future demands on fresh water supplies will require giving very careful attention to possible conflicts among alternative purposes as future programs for water supply developments are planned and revised from time to time. Congress, of course, should not be faced with the necessity of deciding matters that can with mutuality best be resolved locally in cooperation with the federal and state agencies concerned. Congress has recognized the importance of this in the past by enactment of the O'Mahoney-Millikin amendment to the Flood Control Act of 1944. This has been reenacted in all subsequent rivers and harbors and flood control legislation. It calls for state participation in planning for water resources developments prior to consideration being given to authorization. Implementation of these provisions should be strengthened, and the views of state and local agencies should be considered in connection with the formulation and operation of all federal water resources programs.

The importance of government policy in meeting the water resources problems ahead cannot be denied. The recommendations which follow are based on the committee's belief that future demands can be met best by finding the proper combination of (1) construction program; (2) scientific research; (3) development of known technical methods; and (4) strengthening of government policies affecting water development and use. Such a combination of efforts cannot be achieved overnight, and will require the combined efforts of the legislative and executive branches of the federal government, as well as a continuation and strengthening of work in these fields by state and local governments and private enterprise.

D. RECOMMENDATIONS

In the light of the aforestated findings, and in consideration of the matters brought out more fully in the discussion contained in Part II * of this

* Part II of the report, not reprinted here, is entitled "Substantiating Material."

report, the following recommendations are made:

1. The federal government, in cooperation with the states, should prepare and keep up to date plans for comprehensive water development and management for all major river basins of the United States. Such plans should take into account prospective demands for all purposes served through water development, giving full recognition to nonrevenue-yielding purposes such as streamflow regulation, outdoor recreation, and preservation and propagation of fish and wildlife, and keeping in mind the ultimate need for optimum development of all water resources. All practicable means of meeting demands should be considered. The executive branch should be requested to submit plans to the Congress in January 1962, for undertaking and completing such studies in all basins by 1970. Once prepared, the plans should be brought up to date periodically. Reports on individual projects submitted to the Congress for authorization should specify how the project fits into the comprehensive long-range program and the range of alternative purposes that might be served by the resources needed for the recommended projects.

2. The federal government should stimulate more active participation by the states in planning and undertaking water development and management activities by setting up a 10-year program of grants to the states for water resources planning. A minimum of about $5,000,000 in federal funds should be made available annually for matching by the states for use in the preparation of long-range comprehensive plans for water resources development along the lines recommended in No. 1 above.

3. The federal government should undertake a coordinated scientific research program on water. This should include both research into ways to increase available supplies and ways to increase efficiency in the use of water required to produce manufactured goods and crops. The committee recommends that existing programs be strengthened by the following actions:

a. Expanding the programs of basic research dealing with atmospheric physics, solar activity, hydrology of ground water movement and recharge, the physical chemistry and molecular structure of water, photosynthesis, climatic cycles, and other natural phenomena associated with water in all its forms. Such research is essential to a major breakthrough in such fields as short- and long-range weather forecasting, weather modification, efficient management of underground reservoirs, evaporation reduction, desalinization, and pollution abatement, as well as to major improvements in works for the storage and control of water.

b. Providing for a more balanced and better constructed program of applied research for increasing water supplies through desalinization, weather modification, and evaporation, and evapo-transpiration reduction.

c. Providing for an expanded program of applied research for water conservation. Special emphasis should be given to research on improved waste treatment methods, on ways of increasing efficiency in the agricultural use of water, on fish and wildlife needs, and on methods of system planning for the optimum development of water resources of river basins.

d. Evaluating completed projects with a view to determining modifications to enable them more effectively to meet changing needs, to provide bet-

ter guidelines for future projects, and to better determine their effect on the local, regional, and national economy.

The executive branch should be requested to review present research programs in the field of water and to develop a coordinated program of research designed to meet the foregoing objectives. This should be submitted to Congress in January 1962, so that it can be considered along with the budget estimates for the 1963 fiscal year.

4. The federal government should prepare biennially an assessment of the water supply-demand outlook for each of the water resource regions of the United States, as a means of informing the Congress and the public of current and prospective public action needed to meet future demands. The executive branch should be requested to submit the first such report to the Congress in January 1963.

5. The federal government in cooperation with the states should take the following steps to encourage efficiency in water development and use:

a. Regulate flood plain use as a means of reducing flood damages whenever such regulation provides greater net benefits to the national economy than would be provided through other methods of preventing flood losses. Additional steps should be taken to delineate flood hazard areas so that the public will be aware of the risks involved in occupying flood plains.

b. Study the emerging water problems of the areas in which water shortage will be most acute by 1980, with a view to finding ways that these water shortages can be dealt with in such manner as to minimize adverse effects on the economy of the area.

c. Study the future needs for major storage reservoirs for river regulation for all purposes, and report to the Congress with specific recommendations as to steps that should be taken to preserve any necessary sites so that they will be available for use when needed at minimum cost.

d. Provide for public hearings to be held in the vicinity of federally sponsored water resources facilities whenever such facilities are proposed for development or whenever any major change in works or policies is to be made. Prior to the hearings, the proposed change or development should be made public, and comments should be solicited from state and local agencies and from organizations and individuals affected.

The committee hopes that appropriate legislation to implement these recommendations will be introduced in the Senate and considered by the appropriate legislative committees.

Problems of System Expansion by Annexation

H. Buford Fisher

A paper presented on Oct. 25, 1960, at the California Section Meeting, Long Beach, Calif., by H. Buford Fisher, Staff Assistant, East Bay Municipal Utility Dist., Oakland, Calif.

BRINGING a river to a city is a task which has faced and is still facing quite a number of California's metropolitan areas and larger communities. This problem involves not only the transmission of the water but also the long-range planning of a distribution system that will prove adequate in providing for the logical growth of the service area. The water supply situation confronting smaller communities, although not of the same magnitude as that of the larger areas, in many areas is more critical. The utilities serving the smaller areas are faced with the problem of finding and obtaining additional water for service area expansion and of financing such a project. In California, the efficiency and know-how with which water utilities, both publicly and privately owned, are able to function in meeting expansion demands actually governs the development of metropolitan areas and communities. Thus, a water utility, more than any other utility, actually holds the key to area growth.

The rapid growth of the East Bay Municipal Utility District (EBMUD) water service area is typical of the expansion of the service areas of other water utilities throughout California. Perhaps the methods of planning for and controlling this growth pattern differ somewhat from those of other water service jurisdictions. It may, therefore, be of general interest to explain briefly EBMUD's handling of East Bay area expansion.

Ultimate Service Area

Shortly after EBMUD was formed in 1923, an ultimate service area was established based on a thorough study of the East Bay area, namely, portions of Contra Costa and Alameda counties. Special attention was given to the service areas of existing privately and publicly owned water utilities. The early establishment of an ultimate service area boundary, enclosing an area of 400 sq mi, has permitted EBMUD to plan its transmission and distribution system more thoroughly. It has also been of value in obtaining essential water rights to insure an adequate water supply to meet the potential growth of the East Bay area. The establishment of an ultimate service area, although extremely helpful, has by no means been the solution to all of the EBMUD's expansion problems.

At the time EBMUD began operating the water system, it comprised a service area of 92.5 sq mi, or about one-fourth of the ultimate service area. Through the annexation of contiguous areas, lying within the ultimate service area, the district has increased its service area to 245 sq mi. This increase

represents a growth of 143 per cent in 31 years. The expansion of the service area has resulted from 139 annexations, ranging in area from approximately an acre to an unincorporated territory comprising over 12,800 acres, or 20 sq mi. Since its formation, the district has annexed four cities, nine county water districts, and a number of large unincorporated territories, including industrial areas.

EBMUD has never actively sought to annex new territories. In each case the request for annexation has come from the residents or owners of the territory desiring annexation. This approach, from a public relations viewpoint, has proved to be ideal. It tends to eliminate any objections on the part of the residents or property owners to EBMUD's terms and conditions of annexation. In all annexations, the effect on the original area of the district has been considered. The district's philosophy as reflected in its annexation policy is that each annexation should pay its fair share of the cost of service.

Requests for Annexation

Requests have been received for EBMUD to annex and provide water service to large areas in which residential development has already occurred. These requests are generally presented by an interested group representing the area. Such areas, of course, are already receiving water service from either a publicly owned, privately owned, or mutual water system or a combination of systems. District representatives meet with the group which is seeking information and advice as to how to proceed to obtain water service. If the area involved meets EBMUD's annexation requirements and it is evident that there is considerable interest in annexation on the part of the residents, the group is apprised of the district's willingness to make an investigation of the matter. One of the early suggestions made to the group is that a water committee be formed representing all sections of the area.

Economic Studies

Once presented with the problem, the district analyzes the existing water system as to its temporary- and permanent-use values and prepares a tentative layout of a water system to meet its requirements. From this study, estimates are made of the district's share and the area's share of the cost of annexing the system and bringing it up to EBMUD standards. The economics and other aspects of the proposed annexation are then carefully studied. The pertinent findings are reported to the committee, together with the district's preliminary decision on the matter of annexation.

EBMUD's economic study of the problem of providing water service to a proposed area hinges on the district's capital advance for the project and the incremental operating costs of furnishing water service to the area. The rule that the district has been applying to such studies is that its capital advance should be paid off from the income received from the area within 15 years. This income must also provide for the incremental operating costs as well as the interest on the balance due on the capital advance. By the end of the 15-year period, the income from the annexed area then pays its full share of EBMUD's debt service on outstanding water bonds as well as the district's total operating expenses.

Presentation of Findings to Area Groups

The findings, generally presented to interested groups in a fact sheet, include such items as those described below:

Annexation charges. District annexation charges were initially based on back taxes—that is, the taxes the area being annexed would have paid, had it been in the district from EBMUD's inception. Owing to the difficulty of compiling these back taxes, the district established a schedule of charges in lieu of back taxes for residential and commercial areas. The charge involves a combination of a per-acre charge of $4, a per-parcel charge of $3, and an overall charge of $220, regardless of the area involved in the annexation. Special consideration is given to establishment of annexation charges for industrial areas.

Area's share of the cost. The area's share of the cost of a water system to EBMUD standards is determined on the basis of the cost of 6-in. mains throughout the service area of the territory involved. EBMUD provides for the oversizing of mains—namely, the difference in cost between 6-in. mains and larger mains—and for required pumping and storage facilities, service lines, and meters. At the present time, the district's basic charge for a 6-in. main in pavement is $5.90 per foot.

Credit for the purchase of existing system. The depreciated value of existing mains meeting EBMUD standards—that is, pipe of a diameter based on designed needs and of acceptable quality—is determined after establishing the basic values of these facilities. Pipe materials of acceptable quality include asbestos-cement, cast iron, and cement-coated and -lined welded steel. The depreciated value of all service lines, meters, and meter boxes meeting EBMUD standards is also established by the district.

The depreciated value of portions of the existing water system unacceptable to EBMUD for permanent use but of value while the existing system is being brought up to EBMUD standards, is also determined. This value, which is deemed equivalent to a rental value, is established on a percentage adjustment of the basic value and a shorter useful life. If existing facilities are considered to have a salvage value, some additional credit is given.

Quality of supply. A comparison of the quality of the existing water supply with EBMUD's supply is given, generally in terms of total hardness.

Comparison of water costs. Examples of comparative area costs to consumers, based on typical uses of water and assessed valuations of improved property, are also shown. Owing to the marked difference between EBMUD water rates and those of other utilities in the area, these comparisons invariably indicate a saving to the average householder under EBMUD operation. This is true even when both EBMUD taxes and county water district taxes or assessment district levies are added.

Methods available for financing. The advantages and disadvantages of the various methods available to the residents of the area for financing their share of the cost of an EBMUD water system are outlined. The primary methods of financing are through the formation of either an improvement district or a county water district.

Probable initial tax rate or assessment. The probable initial tax rate, if the area elects to form a water district, is estimated and presented. If

an improvement district procedure is selected, a rough estimate of the probable assessment is computed.

The residents and voters of the area are thus apprised of all of the facts before taking the necessary steps to form either a county water district or an improvement district. EBMUD representatives, if requested, meet with various organizations and groups throughout the area to offer an opportunity for all interested parties to have their questions answered.

Financing of Area's Share

The county water district procedure and the improvement district procedure both offer certain advantages in the financing of the area's share of the cost of improving a water system to meet EBMUD standards. These are discussed below.

County water district. The advantages of the county water district procedure are that:

1. Bonds issued are general-obligation bonds, which bear a lower rate of interest than improvement district bonds.

2. The area has official representation through a duly elected board of directors, which has the power to carry on negotiations and enter into agreements.

3. The district can take over existing water systems before the required improvements are made, whereas under an improvement district procedure, all construction work necessary to bring the existing water system up to EBMUD standards must be completed prior to takeover; the county water district procedure thus permits the district to give some credit for the transfer of existing water facilities not meeting EBMUD standards.

4. General-obligation bonds are not a lien on individual properties, whereas improvement district bonds do become a lien on the holdings.

5. As the area develops, the tax rate, which is established to redeem and pay the interest on the bonds, decreases. This reduction in the tax rate is due to the increase in the assessed valuation of the area, as well as the decrease in interest payments.

Improvement district. The advantages of the improvement district procedure are that:

1. It generally requires a shorter period of time to accomplish the annexation and to provide water service in the smaller annexations.

2. Individual property owners can elect to pay their assessment prior to the issuance of individual bonds.

Determination of Area's Share

In making provisions for EBMUD water service to an area, whether or not an existing water system is involved, the area is charged for all main installations required on the basis of the EBMUD's established charge per foot of 6-in. main. If a larger main is needed, EBMUD pays the difference in cost between a 6-in. main and the larger main. If there is an existing water system to be purchased by the area, EBMUD allows certain credits to the area for the purchase and transfer of this system to EBMUD.

Generally, EBMUD does not directly purchase the facilities of the existing utility. It does, however, to an extent, control the acquisition of such systems, through negotiations, by stipulating the boundaries of the area it will agree to annex. The district thus prevents piecemeal chopping up of the existing system, which would prove uneconomical for all concerned.

EBMUD bases its valuation of the existing water facilities on their value to its operations. It then offers a water district board of directors or a water committee a firm credit for the acquisition of the system. The representatives of the local area are thus in a better position to negotiate for the purchase of these facilities. Such negotiations have resulted in an area's having to pay more than the district's firm offer, but in some instances savings have resulted.

Determination of EBMUD's Share

Under present policies, EBMUD pays for the oversizing of mains, the installation or acquisition of service lines and meters, and the installation or acquisition of pumping and storage facilities, including the purchase of the sites. EBMUD's share of the cost of providing water service to annexed areas, therefore, varies from a nominal percentage of the area's share of the cost of the project to as much as 100 per cent more than the area's share. The difference in EBMUD costs would depend on the number of structures and the number of oversized mains involved. EBMUD's share of the cost does not include its capital investment in major transmission mains, principal storage reservoirs, filter plants, and other "backup" facilities necessary to make water available to the annexed area.

If the district bears the greater share of the cost of bringing a water system up to standard, the annexed area, in acquiring an existing water system, must absorb any additional cost above the firm credit for the existing system given by EBMUD. This assumption of the higher acquisition costs by the local area is particularly justifiable, because the acquisition of an existing water system permits the area to receive EBMUD water service at a much earlier date. The early operation of the system by EBMUD is made possible by the temporary use of portions of the existing system until they are gradually brought up to EBMUD standards.

If EBMUD bears the greater share of the cost, the reason is generally one of economics. In most cases it is more economical to install larger transmission mains and storage facilities to meet long-range water demands than to construct smaller facilities to meet only immediate needs.

Annexation of Area With System

In a recent annexation, the members of the area water committee, after weighing all of the conditions, elected to form a county water district. The annexation, which was one of the largest annexations to the district, encompassed an area of 16 sq mi known as San Ramon Valley. This territory is located south of the city of Walnut Creek, already served by EBMUD. Most of the 5,000 active accounts in the San Ramon Valley area were served at the time by a large private utility, the California Water Service Co., as a portion of its Contra Costa Division, and by seven small systems, the largest of which had 150 customers. The California Water Service Co., when approached by the water committee of the local area, expressed a willingness to sell the San Ramon Valley section of its system.

Initial Problems of Annexation

The initial problems were for EBMUD to assist the newly formed water district in reaching agreements with each of the water companies on: (1) the purchase price and procedure for the acquisition of the individual

systems; (2) the establishment of various basic values for the acquisition of new installations and for the retirement of any existing facilities; (3) the general arrangements for the closing of the agreements and the transfer of the existing facilities.

EBMUD gave assistance in the determination of the maximum amount of the bond issue required to finance the water district's share of the cost of a water system designed to meet EBMUD standards.

The agreements mentioned above also had to be acceptable to EBMUD. The assistance of EBMUD's legal department was essential and proved extremely valuable in the preparation and approval of all agreements. Certainly many legal pitfalls can be avoided by sound legal counsel throughout annexation proceedings.

Obviously, it is in the best interest of the district to establish and maintain good rapport with both the area water district and the water utilities presently serving the area. This is highly desirable in order that the negotiations may proceed smoothly and improvements may be made during the interim. Incidentally, the interim period in the San Ramon Valley annexation, owing to problems which developed in the area, extended over 1½ years. The San Ramon Valley project involved over 122.5 mi of mains, which included existing mains meeting EBMUD standards, the replacement of mains termed unacceptable, and the installation of new pipelines in streets where mains did not exist.

It was agreed by all parties that detailed design drawings on each proposed improvement or main extension within the area water systems would be prepared. These drawings were then submitted to EBMUD's engineering department for review and approval prior to installation. This procedure gave assurance that all installations would be made to EBMUD standards. It also permitted credit to be given to the county water district for such acquisitions at the basic value provided for under the terms of the agreement.

Communications

To keep all interested organizations and individuals informed on the progress being made in completing the various steps essential to the closing of the agreements, frequent meetings were held and letters and memorandums of instruction issued. It was also necessary for all parties to cooperate in resolving problems presented by subdividers and individuals requiring water service during the interim period. In order that the residents of the area might be kept informed of what transpired, frequent press releases were issued and a number of letters of explanation were mailed to all consumers in the local area. The county water district had to conduct three elections to accomplish the annexation, as well as the takeover of the existing water systems by EBMUD. The value of good public relations and of open channels of communications with the residents and electorate of the area is borne out by the results of these elections: the formation was approved by a vote of 5 to 1; the $3,500,000 bond issue was approved by a vote of 10 to 1; and the annexation was approved by a vote of 24 to 1.

Water Pressure Problems

From EBMUD's viewpoint, one of the major problems which had to be resolved was the matter of water pressure to the consumers. The existing

system was operated primarily through a major pumping zone, with a minimum of storage and with smaller pressure tank systems supplying the higher areas. It was necessary for EBMUD to change, without too great an increase or decrease in existing pressures, to a combination of one gravity zone and a large pressure zone. The smaller pressure tank systems were to continue temporarily to serve the remainder of the area. The changeover, therefore, had to be made as efficiently as possible.

The foregoing program was necessary until six new storage reservoirs and tanks could be constructed, thus permitting the establishment of pumping-gravity zones throughout the service area. Pressure in these systems ranges from approximately 40 psi at the top of the zone to about 130 psi at the bottom.

Improper permanent zoning can result in many unsolvable consumer complaints. EBMUD, recognizing the importance of careful planning, endeavors to prevent such a problem from arising. To accomplish this in the San Ramon Valley, a very thorough study of pressure conditions within the existing water system was undertaken prior to the takeover. On the basis of the findings, the most desirable pressure zones, as permitted by the terrain of the area, were established. The initial zones were so selected that in most cases permanent storage facilities would provide near-ideal pressures.

Official Map

In view of the difficulty of describing in the written agreement the details of the locations of existing mains and places where replacements and new mains were to be installed, an official map was prepared and made a part of the agreement. The map, through the use of symbols, delineated the mains and clearly established EBMUD's future responsibility for main installation. The map has proved to be exceedingly helpful in dealings with the public. By its use in the business offices, applicants for water service can be shown existing and future distribution system situations. Any possible controversies as to the intent of both EBMUD and the county water district regarding main installations can thus be avoided.

Critical Construction Areas

After the terms and conditions of the written agreements had been carried out by all parties and the closing of the agreements and takeover of operations of the existing system had been arranged, EBMUD advised each customer by letter as to what was going to happen. Any problems that could arise were clearly set forth. Giving the residents all the facts has paid off as is borne out by the excellent public relations that EBMUD has enjoyed.

In several of the critical problem areas where major transmission mains were to be installed or some pressure changes were necessary, meetings were held with key representatives of the areas to explain the situation. The residents were also apprised by letter and through press releases of the problems involved and the progress being made toward completion of the work. This program has resulted in a minimum of complaints and a willingness on the part of the residents to await the completion of major developments.

Some of the projects will require a number of years to complete.

An example of one of the problems involved is the construction of both a 15-mil gal open-cut reservoir and a $1\frac{1}{2}$-mil gal prestressed concrete storage

tank in a relatively confined and rather steep hillside area. This area had been subdivided into a high-value, ranch-type home development. In addition to the storage facilities, large transmission mains had to be installed in the two winding and narrow streets, which had extremely substandard pavement.

A meeting was held with the representatives of the improvement association established in the area. EBMUD representatives painted a rather dark picture of the conditions facing the area for a period of at least 1½ years. Particular stress was laid on the first 6-month period, when the mains would be installed in the streets. The end results of these improvements were thoroughly explained—namely, a change from no water storage to ample storage to meet the peak demands and provide fire protection for their area and adjoining areas as well. The necessity of installing ample transmission and distribution mains and standard hydrants to replace the existing 2- and 3-in. lines and small standpipes of the 50-customer private system was explained.

The improvement committee, based on the district's explanation, prepared and mailed a memorandum to all residents giving them all the facts—unpleasant as well as pleasant. All of the projects, except for the covering of the open-cut reservoir, have been completed; no major complaints and very few minor ones have been received.

Planning of System Takeover

During EBMUD's activities in completing the program necessary to accomplish the takeover of the existing systems in the San Ramon Valley area, good liaison had to be maintained. Each department and division head, as well as all key EBMUD employees, were kept informed of progress being made and the problems to be resolved. This was done both through meetings and by written instructions issued from time to time. Memorandums set forth the definite assignments for which each section was responsible and noted the deadline for completion. As decisions were made and policies established relating to the annexation, memorandums covering these matters were immediately released to all employees concerned. The end result was rather smooth progress leading up to the takeover of the existing water system. It is obvious that extremely close cooperation between divisions and departments is essential to the sucess of such a project.

EBMUD field forces worked very closely with those of the California Water Service Co. in making the necessary connections between the two systems and in valving off these connections in preparation for the takeover. Some of these operations involved the construction of new mains within the existing water system to insure good pressure conditions when district service began. It was also necessary for EBMUD to construct two large pumping plants and have these connected to the principal existing transmission mains before transfer of service. A major transmission main also had to be extended to the area by EBMUD and connected before takeover.

A week before the beginning of district service to the San Ramon Valley area, every customer was mailed a letter of welcome from the president of EBMUD's board of directors. This procedure is employed in other areas as well. Accompanying the letter was a brochure explaining the organization of EBMUD, its source of supply, and the water treatment process used. The

letter gave the date of commencement of water service and briefly outlined the initial and long-range problems of providing water service to the area. A typical paragraph of explanation was:

> In the beginning, the most noticeable improvement will be in the quality of the water. However, the first day or two, harmless sediment may appear due to temporary shutdowns for the purpose of making connections to the system, and also because the flow in some mains will be reversed. General service improvements will follow as new storage reservoirs and key transmission mains are constructed. We ask that you bear with us during the period in which these new facilities are being built.

Conclusions

Whatever success EBMUD has achieved in accomplishing the annexation of the larger areas to its water service area, particularly where the acquisition of existing water systems is involved, may be attributed to:

1. Establishment of a close advisory relationship with duly elected boards and water committees.

2. Careful planning of each step of the annexation procedure and each phase of the providing of water service.

3. Determination of the definite assignments to be accomplished, including the preparation of a check list of these for the guidance of district personnel and the establishment of a deadline for the completion of each assignment.

4. Immediate alerting of all concerned when decisions are made that affect the course of action.

5. Recording the results of contacts made with area and utility representatives to keep EBMUD personnel informed.

6. Maintenance of a proper followup of any problems that develop.

7. Close working with legal counsel to avoid legal pitfalls.

8. Maintenance of an intelligent liaison with the representatives of the local area and existing utilities.

9. Keeping the electorate and their representatives well informed through letters, press releases, and group meetings.

The points enumerated above might be summed up as the practice of good teamwork; a willingness openly to present all of the problems and conditions; and the establishment of sound public relations with the residents of the area to be annexed.

Meeting the Challenge of System Growth at El Paso

Elwood J. Umbenhauer

A paper presented on Oct. 18, 1960, at the Southwest Section Meeting, Galveston, Tex., by Elwood J. Umbenhauer, Gen. Supt., Water & Sewer Systems, Public Service Board, El Paso, Tex.

PRELIMINARY figures from the US Bureau of Census show that El Paso, Tex., has grown in 10 years from a population of 130,000 in 1950 to a population of 272,000 in 1960. Although it is true that some 50,000 people were added as the result of annexation, the expansion has been explosive, and the rate of growth has been exceeded in but a few major cities in the United States.

El Paso Water Problems

El Paso is located in one of the larger areas of deficient rainfall in the United States, and supplies of fresh water are scarce and difficult to find. The topography and terrain are rough, and the large range in elevation, approaching 1,300 ft between the lowest areas being served and the uppermost reservoirs, necessitates the operation of a number of water pressure systems, and the pumping of quantities of water through several booster stations and levels in series. Peak-day use has grown from 29.1 mil gal in 1950 to 88.9 mil gal in 1960; average daily use has grown from 18.5 mil gal to 50.5 mil gal. The number of services grew from 21,044 to 56,660 in the same 10-year span, and the increase in water mains has been from 210 mi to more than 750 mi.

The best estimates available have not adequately warned of the amount of growth to be expected. The reports deescribed below were all made by nationally known firms.

One report, made in 1940, predicted a peak day of 30 mil gal in 1960. This figure was exceeded in 1949. Another report, made in 1951, predicted a peak day of 48 mil gal in 1960. This figure was exceeded in 1956. Yet another, made in 1952, predicted a peak day of 41.8 mil gal in 1960, which was exceeded in 1956.

Estimates made by the El Paso water utility of anticipated peak use in 1966, published in 1954 and in February and October of 1956, were exceeded respectively in 1956, 1957, and 1958.

Several of the reports, in stating the premises on which their estimates were based, said, in effect, that the estimates would be reached only if the rate of growth at that time continued, but mentioned that the rate was so unreasonably large that it could be expected to decline shortly.

Despite the inaccuracy of demand predictions, the El Paso public service board has managed to supply enough water every summer to meet the demands of the city. It has managed to enlarge the system to meet these de-

mands with water bonds totaling approximately $9,000,000 and with a water rate lower than that of any major city in the state of Texas. There has been only one 4 per cent increase in rates, which was directly due to the acquisition of an independent water district with rates and a ratio of indebtedness far higher than those of the city.

A rate of growth beyond all expectations, the difficulties of finding water in an arid region, the desire to maintain a sound financial condition with a minimum of bond issues and rate changes, have presented the public service board and its management with a real challenge.

Factors of Success

Among the many factors responsible for the accomplishments of the past 10 years, four, perhaps, have had greater influence than others, each playing a key part in the continual struggle to meet growing demands, and each essential to success: (1) the creation of the public service board; (2) the aggressive search for new sources of water supply; (3) the extension policies of the city of El Paso; and (4) the construction policies of the city.

The creation of the public service board has placed the overall direction of the municipal water system free from political influence and made it possible for the same directors to continue in office long enough to allow consistent long-term programs to mature and give a measure of continuity to operations.

The aggressive search for new sources of water has developed supplies adequate to answer, however temporarily, the question: if it becomes necessary to supply more water, where will it come from?

The extension policies of the city have opened new sources of income and made it possible, by and large, to meet the growing demands without intolerable increases in rates to existing customers.

The construction policies have enabled the city to receive the utmost value for each dollar expended

In addition to the factors listed above, luck has also certainly played a part; however, without determination, foresight, and experience in the areas outlined above, management would surely have failed at some time to meet the water requirements forced upon it by the rapid growth of the city.

Formation of Public Service Board

The first factor to which the success of the municipal water and sewer system can be attributed is the creation of its governing body, the public service board, and the financial stability and policy continuity which were gained from its creation.

Early Organization

Before the establishment of the public service board, policies of the water department were formulated by the city council, who also controlled departmental finances. It was necessary for the department to compete yearly for its own revenues with other city departments, and, on several occasions, money was transferred from the water department to the city's general fund. An advisory water board existed, but its influence varied directly with the confidence of the city council in its judgment, and recommendations of improvements, considered absolutely

essential by the advisory board, were sometimes passed over.

The first water board was appointed in 1921 for the specific purpose of making a single study of the water resources of the city. The board was dismissed when its report, the most comprehensive one ever made up to that time, was completed.

A permanent city water board was appointed in 1929. This board served only in an advisory capacity, and its decisions had to be put into action by the city council. It did not have final control over its funds, and it was a recurring recommendation to the council that the board be given independent control over the system.

Formation of Board

In 1951, in an effort to find a long-term solution to the city's water supply problems, the mayor appointed a mayor's advisory committee and a finance committee to assist the water board. These three groups comprised a large cross section of El Paso public life and ultimately joined together in presenting an $11,000,000 bond issue to the people. The issue was rejected by vote, and the city was momentarily in the position of having an inadequate water system and no finances to augment it.

In this atmosphere, the city examined the status of the water board and presented to the voters a proposition for $2,940,000 in revenue bonds. The ordinance providing for the issue of the revenue bonds also placed complete management and control of the system, during such time as any of the bonds were outstanding and unpaid, in the hands of a board of five trustees, to be known as the "Public Service Board." This meant that expenses of operating the water department and its income would both be independent of the city's tax income, and that the payment of its bonds and other indebtedness would be dependent entirely upon water and sewerage revenues.

Until retirement of the first series of bonds and various other series issued in the ensuing years, it is the responsibility of the public service board to provide an adequate water supply for El Paso.

The establishment of the board has eased the problem of meeting the demands of the city by permitting: (1) long-term policies; (2) long-term construction programs; and (3) long-term financial programs. With the appointment of members for staggered 5-year terms, the board is able to maintain continuity of direction, and the importance of this stability can hardly be exaggerated.

Search for Water Sources

In late 1929, the board called upon its superintendent and secretary, A. H. Woods, to prepare a report on the condition and needs of the system. This report was summarized by the Board and presented in a letter to Mayor R. E. Thomason on Dec. 19, 1929. It reported the capacity of the city's nine wells to be 14 mgd, only 500,000 gpd more than the maximum usage in 1929. Although the water was rated as of good quality, the presence of shallow deposits of salt water was also noted. This, it was feared, would contaminate the fresh water at greater depths if the field were overpumped. The letter

made three recommendations for the future: (1) a complete survey of the underground water supply; (2) the establishment of the city's rights to surface waters of the Rio Grande; and (3) the establishment of an independent water board.

Warnings in the Woods report concerning the possibility of salt water encroachment began to be realized in the middle 1930's. On Dec. 3, 1934, the water board was advised that a well had turned saline and was unfit for further use. In a few days, the city began negotiations with USGS for an investigation of the ground water resources of El Paso.

USGS Report

The USGS investigations resulted in a report which for years was considered the standard treatise on El Paso ground water resources.[1] Although the formal publication of the work was delayed until 1945, its contents were known as early as February 1937. USGS recommended that the city start negotiations to secure a water supply from the Rio Grande. The contents of the report could be summarized briefly as follows[1]:

About 10 mgd of recoverable water was being supplied by precipitation to underground storage, for possible recharge to wells near El Paso. From water already in storage, the current rate of pumpage (15 mgd) could be sustained for a period of 7½ years. The rate of recharge could prolong this usage for about 20 years, after which the storage would be exhausted. The cities of El Paso and Juarez and industrial users were already pumping about 16 mgd, thus removing water at a rate that would soon leave the city without even a reasonably sufficient supply. Much of the report dealt with the encroachment of salt water upon the fresh-water supply, and it was recommended that no additional wells be drilled in the Montana Field east of the city, and that pumpage from the area be decreased, because of increasingly mineralized water.

Canutillo Supply

The information in the USGS report, which cost El Paso and the state of Texas about $113,000, gives only slight attention to an underground supply which is now a major factor in the El Paso water supply situation—the well field in the Canutillo area of the El Paso Upper Valley.

At public meetings held in the late 1930's and early 1940's, the danger of salt water encroachment on El Paso's water supply was freely emphasized. Despite a suggestion by USGS that the city explore for water in the Hueco Bolsom area, the water resources of the area were not explored by any extensive drilling program during the geologic investigations of 1935–36. Only three deep wells were sunk in the area to the north of the Mesa Plant. These were the conditions under which Mayor J. E. Anderson appointed a water development commission in late 1939 or early 1940.

Rio Grande Supply

The limitations quoted in the USGS report caused the commission to recommend a new water source, the Rio Grande. A long series of conferences ensued between the city, the US Bureau of Reclamation, and the irrigation districts. Negotiations were carried to the Secretary of the Interior in Washington before a contract for providing the city with a maximum of 7,000 acre-ft per year from 2,000 acres of water right land was finally ap-

proved on Feb. 18, 1941. All rights to the impounded waters of the Elephant Butte Project had already been appropriated. The only way the city could acquire water was to purchase farming land and take it out of cultivation. The contract provides that, once it has acquired such lands, the city may receive a quantity of water not exceeding $3\frac{1}{2}$ acre-ft per acre, or the amount allotted to the farmers—whichever is smaller.

The city suffered the same restrictions as the farmers during the drought years 1951–57. In 1951, 1.75 acre-ft was allotted per acre; in 1952, 2.5 acre-ft; in 1953, 1.9 acre-ft; in 1954, 6 acre-in.; in 1955, 5 acre-in.; in 1956, 4.7 acre-in.; and, in 1957, 14 acre-in.

The city is also limited, under the contract, as to the number of acres of land it may purchase for water use purposes. The 1941 contract provided for the purchase of 2,000 acres of land in Texas. A 1944 revision permitted the purchase of 2,000 additional acres in New Mexico; but a New Mexico state law prohibiting the export of water has made the application of this portion of the contract impossible. This leaves El Paso a maximum of 7,000 acre-ft per year under its water right land program, which is less than 7 mgd—obviously a far from complete supply even in 1944.

New Treatment Plant

The waters of the Rio Grande at El Paso are far from potable, and their utilization required the building of a treatment plant. The plant was originally intended to have a capacity of 6 mgd, but the rapid expansion of surrounding military posts and consequent growth of the city made a change of plans necessary, and before construction began the capacity was changed to 10 mgd. With increasing military activity in the El Paso area, and an increase in per-capita consumption brought about principally by water-consuming air-conditioning, it soon became obvious that the new plant could supply but a small part of the daily requirements of El Paso. Plans were made to double the capacity of the plant, and officials began seeking still another method of securing water from the river.

Ground Water Investigations

New ground water supplies would have to be sought urgently to meet the demands of a fast growing city. The public service board began negotiating with the US Army and Air Force for a cooperative investigation of ground water resources in the area, with the Texas Board of Water Engineers also participating.

The board was interested in exploring not only the area east of the Franklin Mountains, known as the Hueco Bolson, but also the area west of the mountains.

Protection of Ground Sources

Another important point concerned the protection of ground water resources once discovered. It was pointed out that a number of farmers were already using ground waters of the Mesa Field for irrigating crops, thus depleting the supply at an abnormally high rate. It was agreed that the city must find a way to control this pumpage in an area that might comprise the most substantial water resource in the vicinity.

Under Texas law, only ownership of land is considered adequate protection against drilling for water. It was, therefore, suggested that the city consider purchasing all of the land over

the main stream of water discovered by the studies, and that the city take option on this land prior to drilling, rather than after the report had been released.

Discussion with the major property owners in the area of exploration was begun with the objective of securing the necessary options, and the manager was authorized to sign options with payments up to $10 per acre on as many as 50 sections of land.

At this time, the manager gave a favorable report on wells in the Canutillo area. A subsequent bond issue supplied the money to purchase both Canutillo and Hueco land. To insure its future water supplies, El Paso has become the largest landowner in El Paso County, holding title to some 57 sq mi. The 36,794 acres include 22,400 acres northeast of the city in the Mesa well field, and 12,500 acres in the Upper Valley, near the Canutillo field. These are held for the protection of ground water rights. In addition, the city owns 1,894 acres of land in the irrigated areas of the El Paso valleys, all with water rights on the Rio Grande.

Value of New Sources

The lands acquired have been of inestimable value in producing water to meet El Paso's needs. Thirty-three of the 75 wells used by the city are on this land, and they supply approximately 50 mgd of the city's 90-mgd peak demand. Without the aggressive policy leading to the acquisition of this land and the drilling of these wells, the supply would necessarily have fallen far short of the demand.

The increase in value of the land has also added to the financial base of the public service board. Land purchased for $10–$100 an acre now ranges in value from several hundred to many thousands of dollars, owing to the expansion of the city in a northerly direction. Bids on a strategic site in that vicinity recently exceeded $100,000 on less than 2 acres divided into smaller tracts. Sales of a small portion of the original purchases will soon have paid the cost of the original land acquisition program.

Extension Policies

The third factor discussed here, but chronologically the first major step enabling El Paso to meet its growing needs, was the development of its extension policy, formulated after World War II and modified from time to time as circumstances demanded.

Early Policy

In the late 1930's and early 1940's, El Paso's population was reasonably static, and, despite a wartime influx of military residents, and their dependents, had a water supply adequate to meet its immediate needs. The bonded indebtedness was small and there was a cash reserve, which, in the light of prevailing attitudes, seemed ample for normal and healthy growth. The extension policy of the city at that time required the applicant for new service to pay for an extension to his meter at the rate of half the cost of that amount of 2-in. cast-iron pipe necessary to reach him, with the city assuming the cost of all labor, fittings, and additional material cost for pipelines larger than 2 in. Under this policy the main became the property of the city and no refunds were possible. In

the event a main already existed adjacent to a property, no extension fee was charged.

The policy led to numerous conflicts. For example, four potential customers would band together to have an extension constructed, and, after all arrangements had been made, one would withdraw. The three remaining would then divide the cost among them, and the extension would be made. At this point, the fourth party, who had withdrawn, could legally apply for service on the ground that a main existed adjacent to his property, and service would have to be furnished without any payment of frontage charges. No argument could convince the three who had paid for the extension of the justice of this arrangement.

The policy on sewer extensions differed in that the first 100 ft of extension was made free. Six homeowners, banding together, could call for 600 ft of free extension. This, although pertaining to sewage, is directly of interest here, as the sewer extension policy was the direct cause of changes in the overall frontage policy of the city. Immediately after World War II, a single subdivision pioneered the housebuilding program for the city. Inspection of the plans proved a shock to management. Under the existing extension policies, the entire surplus of the water department would have been exhausted in providing services to this one subdivision. It was apparent that some changes were essential, as there were definite indications that other subdivisions would soon follow.

AWWA Report

At about the same time, a report from an AWWA committee was made available.[2] This report said, among other things, that extension policies should be such that: (1) the existing customers should not be penalized to provide service to new customers; and (2) charges for extensions to new customers should not be so high as to be prohibitive. With these principles in mind, and with information obtained from every city possible regarding their extension policy, management wrote two ordinances, passed by the city council on Sep. 16, 1948, providing extension charges for water and sewer extensions.

Policy Changes

It was intended that the individual user pay for that portion of any main adjacent to his property, and that the city pay for those lines necessary to complete the network of mains and for fire hydrants. If unserved property lay between that to be served and the nearest main, the applicant was required to deposit with the water department an amount equal to the change to that property, to be refunded as the intervening properties tied into the system.

It was intended to make higher charges for larger properties, as longer mains would be required to surround them, and to make higher charges for larger service sizes, as these required both larger mains and supporting systems.

It was further intended that any unserved property, whether or not new mains had to be constructed to connect it to the system, should pay an extension charge, on the theory that the extensions had been paid for either by other parties or by the city and no contribution had been made to the water system by the unserved property through the payment of bills. Charges for unserved property were made identical, regardless of whether main ex-

tensions were necessary. This ordinance then provided for a payment for extensions based on the number of feet of frontage, times a sum of money called a "basic contribution unit," times a depth factor. The basic contribution unit was established in September 1948 at a figure equal to half of the cost of a 4-in. main. It was increased in 1950 to 85.5¢ per front foot.

Over the ensuing years, various changes in the ordinance have been found to be necessary. Increasing cost factors made the basic contribution unit too low. The original ordinance was written for a city laid out on rectilinear plan, but certain anomalies developed as new subdivisions were drawn on curvilinear plans, and considerable engineering inguenuity was required to make the rules fit irregular tracts of land.

Services to certain large tracts of land, such as hospitals and schools, created unforeseen problems and necessitated revisions to the ordinance. As a result, the frontage regulations were completely rewritten in 1957.

Present Rules

As the public service board, which has the right to establish its own rules and regulations, had been established in the meantime, two ordinances were repealed and completely rewritten as rules and regulations of the public service board, incorporating the changes enumerated above. The public service board now operates under these rules. In principle, it is the intention of these rules to collect a frontage charge based on twice the length of the centerline of the street from which service is given increased by factor of four-thirds (the average number of feet of main in a subdivision per foot of frontage), a factor for the depth of property served, and a factor for increasing service size. The rate per front foot—determined by the average cost for a number of subdivisions under construction at the time the rules were written and intended to be three-fourths of the total cost of the mains installed, regardless of size—is $3.52 per front foot per inch of service. During 1959 alone, $2,500,000 worth of water mains and $1,750,000 worth of sewer mains were installed under these frontage rates.

Special Contracts

Further monies were made available to the board for immediate use under terms of the rules providing that special contracts could be written to furnish water if it would not be a good business investment for the city to install facilities without a contract. Under these, contractors developing in regions calling for such major installations as storage reservoirs, boster pumping facilities, sewage lift stations, and major transmission lines are asked, in addition to their frontage costs, which are not recoverable, to deposit with the city the estimated full cost of these installations. This money is refunded to them either on the basis of frontage along the finished installation or at so much per house served, or a combination of the two. No payments are made after the expiration of a 10-year period. In effect, these contracts ask developers to speculate in new areas at their own expense. If the development is successful and fully built up within 10 years, in general, they stand to recover their entire investment. If the subdivisions are not successful and remain largely unoccu-

pied, the loss is borne by the developer who advanced the money. These policies have led, in large extent, to the limitation of development to areas reasonably contiguous to existing development, and have helped to forestall random, haphazard development.

Special contracts are usually paid back from revenues, but there is some assurance that under the terms stipulated, the revenue will be sufficient to repay the deposits and still leave enough for the satisfactory operation of the system.

Value of Policy

The rapid expansion of the water system has been largely financed through the city's extension policy, which provides that three-fourths of the extension be paid for by the developer in advance and that all extraordinary construction expenses be paid for from monies advanced on deposit by the developer. These revenues and $13,333,000 in water and sewer bond issues in 1952, 1954, and 1956 have enabled the public service board to be financially sound.

Construction Policies

Another major factor that helped the public service board to meet increasing demands in the preceding decade is its construction policy. It is the policy of the public service board to do as much of its own construction as physically possible. This has included to date the major portion of its pipeline work, the drilling of its own wells, and the mechanical work in both water and sewage pumping stations. Construction of a structural type, such as the shells of booster pumping stations, new water or sewage treatment plants, and reservoirs, has normally been let out on contract. It is, however, the feeling of management that any work that can be done by forces of the board should be done by them. It is realized that this policy differs from that of many utilities, but it is the opinion of the board that without this policy there would have been serious deficiencies in its program of furnishing water as needed by the people of El Paso.

Advantages of Policy

There are inherent advantages to the construction by a company of its own facilities. A supervisor who is in charge of the construction of a job and knows that he will be responsible for lifetime maintenance of that same job is likely to have a much greater interest in the quality of construction than a contractor. There are many fine, reputable contractors, but few are ever called to get up in the middle of the night to repair a blown joint in the downtown business district. Another advantage of construction by the utility is the flexibility both of equipment and of order of construction. Equipment normally held available for major repair jobs can be utilized to its full extent on routine construction if not necessary for emergency purposes and, conversely, in the event of great emergency, equipment can be instantaneously diverted to the emergency project. Of specific interest in the meeting of a demand beyond expectations, however, is the ability to change a construction program to meet immediate needs. For example, if four subdivisions start simultaneously, it is almost impossible to plan a construction program with individual contractors which will paral-

lel the individual progress of the subdivisions. By transferring equipment, however, it is possible for a utility to construct only those lines needed, as they are needed. Much of this, of course, is due to the shorter "lead time"—that is, construction can be begun before the final plans are drawn and bids are accepted. In individual jobs the time gained may be short, but, in the overall picture, several months' delay per year can be avoided.

Another advantage of utility construction is that it insures absolute utility control of both materials and standards. Such control is, of course, possible through reputable contractors, but it certainly requires much more effort, on the part of the inspectors, to maintain.

The overriding advantage of doing one's own construction is economy. The El Paso public service board has had limited monies available for construction; stretching these to the utmost by doing its own work has made it possible to do more work in a short period of time than would have been done by contract.

There are several economic reasons why it is more economical for a company to do its own work. The most obvious of these is the lack of a profit motive. The second is the fact that a company can accept the hazards of self-insurance against routine or catastrophic losses at a minimum cost, whereas provision for such losses must always be included in the contractor's price, particularly and especially in the case of well drilling. A third factor is the labor cost; a contractor, by prevailing wage laws, must pay his employees a far higher wage than that for which the utility can hire the men. This differential, which can amount to as much as 30 per cent, is, of course, passed on to the utility by the contractor. The fourth difficulty with contracts is that the bidding procedure is such that it is almost impossible for a company to insure itself against every contingency, remain fair to all of its bidders, and still retain the flexibility of operation which may be made necessary by field conditions. For example, in a region which may contain ledge rock, each and every bidder will have protected himself against the possibility to some extent in his bid price. If a rebate is allowed for the absence of ledge rock, the unsuccessful bidders will complain that bids were not made on equal basis. If the construction is done by the utility, however, full advantage can be taken of the ground conditions at minimum cost. In well drilling, the driller must always protect himself against the possibilities of a dry hole, and this is reflected in the bid price. The bidding procedure also requires performance insurance and various other costs which the utility must pay for, but which can be omitted from jobs it does itself. If all construction is done by the utility, the constant wrangling with subdividers as to which of their contractors will do the work is obviated. This is particularly important if the utility does not have confidence in the contractor specified by a subdivider who has great financial or political influence.

Disadvantages of Policy

There are a number of disadvantages of doing one's own work, as well. The first of these is the public relations problem with local businessmen. Engineering contractors and suppliers feel and vociferously state that when the utility does its own work it robs them of business which they should rightfully have, and that by doing its own work, the government is in unfair competition with businessmen in its own

community. This is a particularly difficult argument to meet, but it can be refuted to a certain extent by the argument that there is no moral obligation for a municipally owned utility to pay a percentage of job monies to individual firms simply because they operate in the community, and, furthermore, that all monies expended by the company are returned to the local economy exactly as though the work were done by private contractor. The question of unfair competition can be resolved to an extent by stating that the utility is a *local* concern and asking whether independent local businesses would rather compete with outside business firms that might take money out of the community.

Another major disadvantage to utility construction is the prevalent public opinion that no government or government-owned agency can be as efficient in its operations as a private company. The press and individuals constantly point out instances of inefficiency on utility-operated jobs, whereas they ignore similar instances in the operations of a private contractor —even though, in fact, the utility pays for the labor in both cases. This public opinion can sometimes be a strong enough factor to cause all work to be done by contractors. Another related disadvantage is the problem of surplus personnel under a fluctuating work load and related problems. Under a civil service system, there may be a temptation to do unnecessary work in order to keep the work forces busy and prevent layoffs.

Possibly the greatest danger when a utility conceives, plans, engineers, constructs and operates its own system is that it will develop prejudices and blind spots, and that its performance may not come up to the standard which is required of consultants. Poor engineering, poor construction, poor inspection, or downright bad planning can waste more time and money than that saved by company construction and operation. The most stringent steps must be taken to avoid the occurrence of this weak link in the chain.

Savings Through Utility Construction

A few examples of the savings obtained by utility construction in El Paso are given below.

In the well drilling program, on the basis of the last bids received, informal inquiries since that date, and a comparison with other bids on similar wells in the vicinity, the following comparisons can be made:

1. For one well, the contractor's price was $65,477.20, and the board's actual cost was $32,679.94—a saving of nearly $33,000.

2. For another well, the contractor's price was $65,477.20, and the board's actual cost was $26,856.29—a saving of more than $38,000.

3. For another well, the estimated contractor's price was $48,163.40, and the actual cost was $31,809.38—a saving of more than $17,000.

4. For twelve wells, the saving is estimated to have exceeded $269,000, and the saving on fourteen other wells is believed to approximate this same amount, although exact figures for contractors' prices are not available.

In large pipeline construction, the laying costs in place of 36-in. pipe by contract and by the board, the pipe being paid for in each case by the board, were: laying cost of 82,116 ft on contract, $3.60 per foot; board cost for equivalent work on 28,200 ft of identical pipe, $3.078 per foot, and on the same 6,000 ft of pipe, $2.80 per foot. (The saving on 82,116 ft of pipe would have been $42,700 or more

if the public service board had done the work.)

A major sewer construction project, which entailed many difficulties, cost the company $21 per foot, including extensive repairs. The best bid for a nearby project of similar difficulty, size, and depth was more than $39 per foot. It should be pointed out, however, that owing to the difficulties of this particular construction problem, such work will probably be done on contract in the future.

Conclusion

It is the author's firm opinion that four factors—(1) the formation of the El Paso public service board, and the consequent continuity of policy; (2) the aggressive policy of seeking water sources; (3) the sound extension policy supported by the board; and (4) the construction of many of the extended facilities by the board itself—have been directly responsible for the successful meeting of the challenge of El Paso's growing water system.

References

1. Water Supply Paper 919, US Geological Survey, Washington, D.C. (1945).
2. Committee Report. Water Main Extension Policy. *Jour. AWWA*, 41:729 (Aug. 1949).

AWWA Animal Identification Manual Available

Animals Associated With Potable Water Supplies—Operators' Identification Guide, which was published in the December 1960 issue of the Journal, is now available as a separate manual (AWWA M7), indexed, and attractively bound in stiff-paper covers. Prepared for AWWA by William M. Ingram and Alfred F. Bartsch, this informative 36-page guide is priced at $1.00 a copy.

Future Developments in Water Supply

Harold H. Yackey

A paper presented on Oct. 27, 1960, at the California Section Meeting, Long Beach, Calif., by Harold H. Yackey, Asst. to the Pres., Garnier Enterprises, La Puente, Calif.

REFERENCES to the "future" in this article pertain to a time approximately 50 years from now—the end of the life of existing supply facilities. Predictions of future developments can be made on the basis of past experience, but, because it is difficult to free the mind of considerations of today's and tomorrow's problems, most thinking is of the immediate present, or, at most, of a year or two in advance.

If the minds of those in the water supply field can be freed from the fetters of present-day problems, great, though seemingly far-fetched, developments can be imagined; the towing of icebergs from the Arctic to places where more water is needed; and the use of balloons to condense water in the clouds, the water running down through anchor cords, made of hose, to ground storage. Hundreds of thousands of dollars have been, and are being, spent for seeding clouds and otherwise attempting to control rainfall. Many experts are engaged in this work, and the future holds great promise. Of course, present means of transporting water and the improvements in, and better utilization of, existing underground basins will be continued, and, where justified, sea water will be converted to fresh water.

Need for Water

Human beings need water for every phase of their being. Furthermore, they need, relatively, a lot of water, for every physical process requires water and every chemical change in the body is based on water solubility. As to how much is needed and how much is used depends, to a great extent, on how Americans will live and on the price of water. At today's costs, piped utility water is extremely cheap compared to other commodities. About 98 parts of water are used to wash 1 part of waste through sewers from bathrooms, kitchens, and laundries. More money is paid for the disposal of used water than for the distribution of fresh water. In some places, sewage collection lines cost twice as much as water supply lines.

Economy

Even though water for California is transported hundreds of miles from the Colorado River and will be transported, in a few years, from the Feather River, it is still so relatively cheap that considerations of cost continue to be ignored. But, in the future, water will begin to cost more, and it will eventually cost enough to call for economies in production and use.

The best watersheds in the United States recover about 10 per cent of all the water that falls as rain. The rest is lost in evaporation and transpiration from trees and brush. The US Forest Service of the Department of Agriculture has been conducting experiments

and studies for years in the relative value of trees, brush, and grasses on the watershed productivity of various areas. For several years past, at the annual meeting of the San Dimas (Calif.) Charter Oak Domestic Water Co., the results of the work on the San Dimas watershed have been reported. Each year, the reports indicate that water-using trees and brush must be removed and grass substituted, but no action has been taken by the Forest Service.

Another step in economizing on production will, of course, be the salvaging of waste water. The feasibility of treatment plants and spreading grounds has been proved for many years. Heretofore, very misconceived ideas of the value of used water have been stated.

Undoubtedly, in the future, the consumption of water will tend to be more controlled. Some of the ways economies may be effected are:

1. Reduction of items that need to be laundered, by the increased use of paper towels, handkerchiefs, tablecloths, napkins, and diapers. Underwear and socks also may be made of paper.

2. Elimination of the need to wash poultry, meats, and other foods by preparing them for cooking at the point of packaging, where the water can be used for crop irrigation. This is done today with salad vegetables, baking potatoes, fancy packed fruits, and all frozen foods.

3. Reduction in the need for dishwashing and dishwashers. More and more foods are being so packaged that they can be prepared in their own cooking and serving foil containers. Some day, most food may be sold this way, and in decorated and fancy containers.

4. More economical use of water for washing and bathing. Navy personnel aboard ship soon learn that baths may be sufficiently cleansing by the "wet, soap, and rinse method." When the water for a wasteful bath costs 15–40 cents, economy will be practiced in a hurry.

5. Less wasteful landscaping of homes. Today, the constant growing and discarding of grass consumes much water, fertilizer, and labor. Homes can be made attractive with less, but better, planting. The big park expanses of lawn and golf courses may be watered with reclaimed waste water, as are many courses at present. It may be possible for waste water from each home to be used on the home property.

Quality and Costs

It used to be said that water is water, regardless of quality. Today there are pollution standards, and it is no longer permissible to discharge waste waters with excessive dissolved solids or excessive amounts of certain elements into watershed areas or stream beds. By the same token, waters of low mineral content and desirable chemical makeup are valuable for spreading—whether they have been used once or many times—and for industrial and agricultural uses.

Most water costs the consumers in towns and cities about \$100–\$125 per acre-foot. Still, many people everywhere buy water in 5-gal bottles for 50 cents to \$1. At 50 cents, they pay \$32,500 per acre-foot. To compare various waters, new and used, and to evaluate them properly, a price formula based on water quality is needed for piped water. An engineer considered to be an authority on water should establish such a formula, with tables and curves to make it simple to use.

A standard of good-quality water delivered to, say, a 500-ft elevation,

could be used as a base. The cost of other waters would depend on how they were treated and from what level they were pumped. Waters of better quality could be used to blend out poorer waters; this would permit greater reuse of water. Only by a real appreciation of the quality of water can the true value of water be recognized.

Supply and Demand

As the price of water increases, and less of it is used, it is inevitable that the size of services to the home will become smaller. Meters will then be smaller, and the present trend in piping will probably be reversed, with pipe sizes becoming smaller. It can be remembered when a normal house service used 0.5-in. pipe. Then the size of pipe increased to 0.75 in., and then to 1 in. Now there are quite a few places that require 1.5-in. pipe. So long as the homeowner wants to water his entire yard at one time, and the service charge for the meter encourages the utility man to give him the largest meter he will take, the services will stay large. But some day homeowners will stop their wasteful use of water and the size of the service will be reduced. The trend of larger pipe will be reversed. The factor that will cause this reversal will be the size of the water bill, for American consumers are cost conscious. Their awareness of the water bill and, consequently, of the water utility may be among the reasons why municipalities will take over water utilities. By that time, the utilities will be so thoroughly tied up in government, regulatory, and employee-bargaining controls that they will be glad to sell out.

If the trend goes toward smaller services, and it is believed that it will, the needed size of distribution mains will also be reduced. From the present minimum of 4 in., the size will probably decrease to 2 in., and an 8-in. main will really be a whopper.

Homes may be equipped with a 20–50-gal elastic tank that will take the surge demand off the supply line when there is a sudden demand for 5 gal or 10 gal of water. The tank will deliver the water and refill, with practically no drop in pressure.

Fire Protection

It may be thought that the size of mains cannot be reduced because of the requirements for fire protection. This is another area where some radical changes will be made. The entire concept of fire protection should be based on the elimination of hazards and the prevention of fire, rather than on fighting fire. The burden of providing fire-fighting water is, today, a very serious problem for the small water system. As the domestic consumption of water decreases, this burden is going to become unbearable.

If water is to be used to fight fires, it should be supplied from trucks instead of by a pumper hooked to a fire hydrant. One community boasts that it has not unrolled a fire hose to a hydrant in 15 years. The time will come when a householder will be assessed the cost of fighting the fire and will be subject to damage suits by his neighbors. If factories and large buildings need water for protection, they should supply their own storage tanks, as many do today.

Equipment, Materials, Labor, and Power

Undoubtedly, many improvements in materials and methods and the better use of power and men will come about in the future. The use of tele-

phone and radio for telemetering and supervisory controls is a familiar one today. The use of this equipment, with the subsequent trend toward fully automatic facilities in the field, has taught that the best system is one that controls and operates itself on a local level, with constant review by a central headquarters station. Such systems emphasize the need for equipment that needs no maintenance. Some motors are lubricated to withstand 10 years of normal usage. Mechanical seals on pumps, the use of strainers ahead of pumps, and ample safeguards and factors of safety in the use of materials and equipment will allow plants to be maintenance-free. In this regard, all manufacturers of equipment must cooperate. An important automatic valve operating in a system must have large control tubing and oversize strainers on the control tubing, and be, in every way, designed to operate continuously without attention—not for a year, but for the life of the unit. In the future, it may be expected that watershed supplies and the spreading of waters in basins will control the level of underground water in such a manner that pumps will be installed to handle the load efficiently, without the necessity for a change in the pump setting and motor size during the life of the equipment.

As to materials used in the water industry, meter and fitting manufacturers are trying hard to find plastic and other material to replace brass. Plastic sheets are being used as linings for reservoirs and for inflatable roofs of tanks. Other materials planned for development are foam forms of steel, aluminum, and other metals. These forms will result in structural members of great strength and light weight. Mixed with, or combined with, plastic foams and various cements, these and other materials will provide economical tank roofs and tank panels. Tanks will then be installed underground, the land surface being utilized for other purposes.

With the increased numbers of people that have to be served, undoubtedly more power is needed to operate water systems, especially because more and more work will be done by machine. The burning of fuel and the internal-combustion engine are on the way out. Sources of power that will be used in the future are actually here today, but they remain unrecognized. Electricity was discovered long before it was used for power. Radioactive materials were studied long before they were used in the atomic bomb. New forms of power different from any known today are sure to be found.

At present, electricity is used most, providing the power for lights, motors, radio, television, computers, and all the other devices built with magnetic fields and electric-coil circuits. The latest power development is based on the energy from the atom. In addition to atomic and hydrogen bombs, atomic energy is utilized in power plants for generation of electricity and for operating submarines. Power units are being planned for surface ships and airplanes.

If one examines a chart showing all chemical elements and their combined weights, he finds that electricity is based on the magnetic series of elements. Likewise, atomic energy is based on the radioactive series. It is probable that there is a power system behind each of the other series of elements and that these systems will soon be used. If each new power system is as great an improvement over the one before as atomic energy is over electricity, a wondrous world is in the offing.

Utility Depreciation Problems and Procedures

William C. Welmon

A paper presented on Oct. 26, 1960, at the California Section Meeting, Long Beach, Calif., by William C. Welmon, Secy.-Treas., Southern California Water Co., Los Angeles, Calif.

RAISING funds for plant replacements is a problem of all utilities. Perhaps the problem is greater for a privately owned utility than for a utility that is publicly owned. New business is financed principally by advances from subdividers. The money advanced for a privately owned utility is refunded to the subdivider over a period of time. Funds for replacements can be obtained only from depreciation money plus the sale of securities for the excess of replacement cost over original cost. But a publicly owned utility, too, must give thought to its depreciation problem, for all property, regardless of the amount of money spent on maintenance, is destined for the junk heap.

Role of Utility Departments

It is surprising how many departments of a utility are affected by, or are concerned with, the depreciation problem. The accounting for depreciation is, of course, done by the accounting department, which must see to it that depreciation entries are made to the proper accounts and that the depreciation reserve by units of property is maintained. Although the accountants compute depreciation and make the proper accounting entries, it is the engineers who must determine the life of the properties and the resultant depreciation rates to be used. Thus, the engineering department comes into the picture.

The operating department may also be affected by depreciation, as replacements and property additions may, in many companies, be dependent on depreciation money. This money is allowed for by the depreciation provision, which provides for cash that can be used for capital improvements and replacements. The rate department, too, is vitally interested in depreciation, as new rates are affected, to a substantial extent, by the amount of the depreciation provision recorded in the expense accounts and the amount of the depreciation reserve deducted in the computation of the rate base.

Also to be considered is the tax department and the depreciation use for income tax purposes. In the past, many utilities had higher depreciation rates for income tax purposes than were used for book purposes. This might appear to be a tax-saving device, but it also can be costly to the utility. For if the utility sells any of its properties, it will pay a capital gains tax on the amount of excessive depreciation. Then, too, when the utility has higher depreciation rates for tax purposes, it is, in effect, subsidizing the present

customer and may later find it difficult to bring tax and book depreciation rates together.

Antiquated Procedures

Depreciation procedures are antiquated in that they do not reflect the changing value of the dollar in periods of rapid price changes. When price levels change only a little year by year, a utility is not adversely affected by present depreciation procedures. But under such conditions as have existed during the past 30 years, a utility has been adversely affected.

Based on the *Engineering News-Record* construction cost index, the replacement today of property installed 30 years ago would cost approximately four times the original cost—that is, property installed in 1930 at a cost of $100,000 would cost $400,000 to replace this year. Under the present method of computing depreciation, the utility would recoup over the life of the property only the original cost, which means that it has to finance $300,000, or three-fourths of the replacement cost. As most companies are dependent on the money market, the obtaining of funds is competitive. It may be easier for a utility to obtain funds for anticipated growth than to obtain funds to replace worn-out property, with no anticipated growth from the use of the funds. Many utilities may have real difficulty in obtaining the required financing of $300,000 if the only benefit is a rate increase.

Some might ask what difference it makes if $400,000 is required to replace property originally worth $100,000, as long as the utility gets the benefit from its rates. But does a utility get full benefit on the extra $300,000 of financing? The author's belief is that it does not. The reason for this belief may be given by an example that has been simplified by the elimination of considerations of "salvage value," "sinking fund," and other possible refinements.

The following may be assumed: (1) the original cost of the property in 1930 was $100,000; (2) the replacement cost of the property today is $400,000; (3) the estimated life of the new property is 30 years; and (4) the utility has, in cash, the original $100,000 from depreciation money. The additional cost of $300,000 above original cost is obtained by financing: 60 per cent of the financing in 5.5 per cent bonds, 10 per cent in 6 per cent preferred stock, and 30 per cent in 6 per cent common stock. Initially, this results in an additional interest of $9,900 plus dividends of $7,200 annually.

As the additional rate base of $300,000 (excess of replacement cost over original cost) will be reduced by $\frac{1}{30}$ annually for the 30-year life of the property, the average additional rate base during the 30 years would be one-half of $300,000, or $150,000. In other words, during the first year, before depreciation is computed, the rate base would be $300,000. At the end of 30 years, the depreciation reserve would be $300,000 and the rate base zero. This results in an average rate base over the 30 years of one-half of $300,000, or $150,000.

A rate of return of 6.25 per cent on the average annual rate base of $150,000 would be $9,375 annually. Although a utility may be allowed a rate of return of 6.5 per cent, it is believed that the slippage due to inflation would, despite recurring rate applications as necessary, tend to provide

an average rate of return that would be closer to 6.25 per cent over the 30-year period.

The use of depreciation money over the 30 years would reduce the interest cost and dividends to an average cost of one-half the initial cost of $9,900 for bonds and $7,200 for dividends. This results in an annual average cost over the 30-year period of $4,950 for interest and $3,600 for dividends ($900 for preferred stocks and $2,700 for common stocks). The percentage of net income tax is 54.64 (52 per cent federal, after allowing for a state tax of 5.5 per cent). This provides for an average annual increase in net income (over the 30-year period) of $4,425—that is, $9,375, or 6.25 per cent on the average annual rate base of $150,000, less an average interest cost of $4,950. But after providing for average annual preferred dividends of $900, there would be left only $3,525—$2,700 for common stocks and $825 for surplus, after the common dividends are paid. If one considers that most utilities pay out in dividends about 75 per cent of their surplus available for common stock, a utility's earnings per share of common stock would be reduced by this required financing.

One major factor in the failure of the financing to provide benefit to the utility is that, under present rate procedures, the need of obtaining $300,000 of additional funds in order to replace property that originally cost $100,000 would result in a rate reduction to the customers of 54.64 per cent of the interest expense on funds obtained by long-term debt. In other words, if the company does part of its financing with long-term debt, the reduction in income taxes caused by the increased interest cost would inure to the benefit of the customers and not benefit the utility. The customers, however, would not receive the benefit of a rate reduction if the company did all of its necessary financing with equity securities.

Another very important point that must be considered is that the utility has a "contingent liability" represented by the difference between a depreciation reserve computed on a straight-line basis and one computed on a replacement basis. Other industries are not required to replace worn-out property, but because a utility has a responsibility to its customers and must make replacements, it does have a contingent liability. When reviewing a financial statement in connection with the financing problems of a utility, financiers are just as interested in a contingent liability as in a recorded liability. The customers, too, are adversely affected, as the $300,000 of additional rate base would initially cause an increase in their water bills of $41,000 annually, and an average increase of $24,700 annually over the 30-year period.

When depreciation procedures are the cause of the creation of a contingent liability, requiring a utility to sell securities amounting to three times the original cost of an asset in order to finance its replacement and thereby reduce the common stockholders' equity, and at the same time cause a substantial increase in customers' rates, it is believed that such depreciation procedures are antiquated and that both the utility and the customers are adversely affected thereby.

Changes in Procedures

It is suggested that present depreciation procedures be modernized to give

consideration to the inflationary forces that are causing the continuing increase in prices. A reference to price levels has indicated that, for a period of more than 135 years, price levels have very seldom receded to previous low points but have had a continuing upward trend; and, conversely, the purchasing power of the dollar has decreased with only temporary partial recoveries. The long-term history of prices even prior to 1940 was a slow, gradual increase at the rate of about 1 per cent a year. This rate, however, has been five times as high during and since the war. Even though it may flatten out or drop somewhat for short-term periods, there is nothing to indicate that it will not resume its gradual trend upward.

In connection with the subject of depreciation procedures, a report entitled "Economic Depreciation, or Capital Recovery Under Changing Price Levels" [1] should be mentioned. The report was prepared by a joint subcommittee of the American Gas Association and the Edison Electric Institute, members of which were later augmented by representatives of the Economics Committee of the American Gas Association. The subcommittee raised the question: "Has the United States ever before experienced periods of inflation, and, if so, why should the country be any more concerned now than it was in the past regarding the present situation?" As stated, a cursory review of price levels shows that there have been a number of periods of inflation; however, the subcommittee takes the position that today's problem should not be ignored merely because similar problems have in the past been unrecognized, ignored, or dealt with by indirect methods.

A review of the history of utilities discloses that changes in depreciation procedures are by no means unusual. Prior to the latter part of the nineteenth century, a provision for depreciation was not generally recognized as a part of the annual cost of doing business. In that stage of accounting development, the expenditures for replacement of property were treated as a cost in the year the expenditure was incurred. Later, it was gradually recognized that such a process was improper; thus, the additions and betterments technique was evolved. This concept considered that the excess of replacement cost over the cost of the replaced equipment was an addition or betterment to the property account, but the cost of equipment that was discarded but not replaced was considered as an operating cost of the current year. Next was instituted the retirement reserve method, which was used by some in utility accounting for a considerable time. This method attempted, by means of arbitrary appropriations from income, to equalize the charges for such retirements as those made between years. The method was based on consideration of the property that was actually discarded, as the amount of the depreciation charged to operations was determined by the actual retirements; and, accordingly, little or no consideration was given to the depreciation on the remaining property. Then came the development of the concept that the proper charge to each year's operation consisted of a ratable portion of the cost of the property utilized. This is called today "depreciation accounting." Many measuring devices were used to determine the annual ratable portion of cost chargeable to operations, such as units of production, hours of use, quantity of sales, dollar amount of sales, and years of life. Regardless of the measuring device, the underlying

purpose was to record as a cost to operations the total cost of the property during its life.

Depreciation Computations

It is not the purpose here to discuss the merits of the straight-line, sinking fund, accelerated depreciation as now approved by the Internal Revenue Service, or to discuss any other method of depreciation. Each of these depreciation methods provides the means of recovering the *original* cost of depreciable assets over their estimated useful lives, but they do not provide the means of recovering sufficient funds to pay for the replacement of the depreciable assets. The basis of subsequent statements is the straight-line or remaining-life depreciation. As is well known, there is no fundamental difference between straight-line and remaining-life depreciation. If at the time of installation of a property, its exact life can be determined, the two methods are the same. But if it is later found that the original estimated life is incorrect, remaining-life depreciation will provide the means for making the necessary adjustments. At any rate, under either method or both methods, present depreciation computations are based on actual original costs and do not take into account the fact that inflationary forces will compel a utility to pay a much greater amount for equipment replacements.

It has been estimated that, because of the inflationary forces at work in the national economy, depreciation provisions each year fall at least six billion dollars short of the amount required to pay for replacement of equipment. This, in effect, means that industry is reporting "phantom profits" of six billion dollars a year. These profits occur because revenues and most expenses appear on the financial statements at the current year's price level, while the depreciation charges against current year's revenue are in terms of prior years' dollars. The use of depreciation on the basis of yesterday's dollar does not properly match revenues and expenses at today's dollar; consequently, income is overstated.

After a utility stockholder has exchanged his dollars for water property, his capital is represented by property, not by dollars. Ultimate recovery of his capital, now represented by water property, is necessarily made in terms of dollars, as it cannot be recovered "in kind." The purchasing power of the original investment, however, can be recovered only if the number of dollars recovered each year is adjusted to the changes in the purchasing power of the dollar since the property was acquired.

The widening gap between depreciation allowed and the inflated cost of replacing equipment has helped the growth of equipment leasing. Answers to a recent survey showed that 21 per cent of all companies leasing equipment did so in order to deduct leasing payments rather than own equipment and take the inadequate depreciation allowance.

Liberalization of Tax Laws

Recently, the US Treasury Department and Congress appeared as new allies for consideration of inflation in depreciation computation. During the past 2 or 3 years, many proposals for liberalizing the tax law relating to depreciation have been placed before Congress. In order better to evaluate the proposals, the Treasury Department, by means of questionnaires, is making a survey of depreciation practices of approximately 11,800 indus-

trial firms, both large and small, representing a cross section of American industry. The data, in composite form, may be available shortly. The Treasury Department stated that many proposals for liberalizing the tax laws relating to depreciation have been suggested to Congress and that this survey has congressional support. Congress, however, must have information about current industry depreciation practices before considering depreciation legislation.

The Treasury Department's questionnaire posed this question: "Do you think the present tax treatment of depreciation should be changed?" The questionnaire provides a space for an answer, with a list of several proposals for changing tax depreciation. One of the proposals was: "some form of depreciation adjustment to reflect increased price levels." This question was then asked: "If depreciation were liberalized along the lines you favor, would you be willing to generally conform book and tax depreciation accounting practices?" Many people believe that tax and book depreciation rates should be the same, in order that a company may provide for replacement of property for book and tax purposes at the same time. Unquestionably, an item of property will wear out for tax purposes at the same time that it will for book purposes.

Americans believe that they have the most progressive country in the world. This is true in most respects, but not in tax depreciation. Such European countries as the United Kingdom, France, Germany, Sweden, Belgium, the Netherlands, and Italy have adopted higher tax depreciation allowances in order to recognize the higher replacement costs resulting from inflation. The same method was not used by each country but each had the same goal—that is, a realistic tax depreciation to prevent the stagnation of capital-goods spending.

The miracle of West Germany's economic recovery was sparked by a 50 per cent tax writeoff the first year for manufacturers who replaced war-damaged plants. Expansion was so rapid that, in 1955, the rate was reduced to 20 per cent to curb too much spending on capital goods. With such fast writeoff, the problem of inflation would be substantially nullified.

Unquestionably, the tax policies, including realistic depreciation allowances, to encourage private enterprise have played an important role in the economic recovery of European countries. One can only hope that the US Treasury Department and Congress will consider realistic replacement tax depreciation allowances that will help to provide funds needed for the replacement of the utilities' worn-out property. Money spent by utilities for replacements would have a very favorable effect on the capital-goods industry of the country.

It should be mentioned here that, in some areas, water utilities are claiming a depletion allowance for tax purposes. In areas where the withdrawals of water exceed the natural replenishment, utilities claim that they are actually mining the water and are therefore entitled to a depletion allowance. It would appear that, under such conditions, their contention is valid and undoubtedly all water utilities are interested in the result of this claim. The depletion allowance is presently 27.5 per cent annually and, if the claims are allowed, would apply to the revenues applicable to the overdraft.

Replacement Depreciation

Many proposals have been made on how to provide for inflation in the com-

putation of depreciation. The idea here is to propose "replacement depreciation" as the means to offset the inflated cost of replacing property.

The idea of replacement depreciation is to prevent the erosion of capital, because of the declining purchasing power of the dollar, and thereby maintain the integrity of the original investment. But in order to have replacement depreciation, it would be necessary to have property records from which the year of installation of the properties could be determined. Computation of replacement depreciation for each year would be based on two factors: first, that prices will, over the years, maintain their "prior to 1940 historical increase at the rate of 1 per cent a year"; and, second, that adjustments will be made yearly, when necessary, if they are justified by existing price levels.

For property with a 30-year life, the yearly replacement depreciation provision would be $\frac{1}{30}$ of the sum of the original cost plus 30 per cent, or the estimated price increase of 1 per cent a year for 30 years. Yearly thereafter, the actual increase in the price level would be compared with the estimated price level increase of 1 per cent annually, and the replacement depreciation provision would be adjusted to reflect changes when necessary if the deviation from the estimated long-term average amounted to 0.25 per cent of 1 per cent or more annually. The customer should pay, by means of replacement depreciation, for the cost of replacing property used in his service, and not pass the burden of inflation on to future customers.

One point should be made clear. Replacement depreciation is quite different from the fast writeoff, or accelerated depreciation, that was made effective for federal income tax purposes in 1954. The proper treatment for rate-making purposes, to be accorded accelerated depreciation, was given serious consideration by most of the utility commissions throughout the United States, and, in California, a conclusion was reached by the California Public Utilities Commission.[2] The vast difference between accelerated depreciation and replacement depreciation should be pointed out. With accelerated depreciation, a larger provision is obtained in the early years; a smaller provision in the later years. But the total depreciation over the life of the asset is the same as would be obtained by straight-line or remaining-life depreciation. With replacement depreciation, however, the provision would be adjusted year by year in order to give consideration to the higher cost of replacing the property. Over the life of the property, replacement depreciation should provide sufficient depreciation money to pay for the replacement cost of the property.

What would have been the effect if replacement depreciation had been in use for both tax and book depreciation during the past 30 years? Replacement depreciation would have provided the entire \$400,000 needed for the replacement of the property that 30 years ago cost \$100,000. Therefore, there would be no adverse effect on the net income of the utility.

The original cost of the replaced property is charged to its related reserve, but the replacement depreciation reserve would remain intact and, for rate purposes, should be an offset to the cost of the newly installed property. As there would be no change in the rate base, the only effect on the customers would be to provide for the depreciation on the \$300,000 of additional property plus the additional

30 per cent of replacement depreciation required. This increased depreciation cost would result in a rate increase of $13,000 annually.

With replacement depreciation, a utility: (1) would not be subject to a contingent liability of the difference between a replacement and original cost depreciation reserve; (2) would not be required to finance the additional replacement cost of $300,000; and (3) would have its customers pay increased rates of only $13,000 annually, compared with $41,000 initially and an average, over the 30-year period, of $24,700 annually based on current depreciation practices. It is clear that replacement depreciation would be an advantage to both the utility and its customers.

To obtain acceptance of the principle of replacement depreciation, it will be necessary to gain the support of the accounting profession, the utilities commissions, and the Treasury Department. Replacement depreciation, however, should not be put into practice until it is recognized by the Internal Revenue Service and by the utilities commissions, for both income tax purposes and rate purposes.

If replacement depreciation is used, certain changes in book entries will have to be made. The provision for depreciation based on original cost and its related reserve should be accounted for as at present. The entry reflecting the difference between replacement depreciation and depreciation based on original cost should be made as a charge against income, with the credit being made to a reserve account. In all fairness, however, this reserve account should be treated as an offset for rate-making purposes.

Conclusion

The recognition of replacement depreciation for tax purposes and in the determination of rates would do no more than permit utilities to recover cost in the same manner that unregulated business recovers all its cost. The equity owners of all industries other than utilities have, to varying degrees, made up for inflation and will continue to do so as long as inflation continues. It is reasonable to seek the same treatment for the equity owners of regulated public utilities.

Reference

1. Economic Depreciation, or Capital Recovery Under Changing Price Levels. Report of a joint subcommittee of the American Gas Association and Edison Electric Institute (1955; *unpublished*).
2. California Public Utilities Commission. Decision 59926 (Apr. 12, 1960).

Landscaping for Water Utility Structures

Joint Discussion

A joint discussion presented on Oct. 27, 1960, at the California Section Meeting, Long Beach, Calif.

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THREE primary considerations enter into the construction of a public water facility: (1) engineering feasibility, (2) cost, and (3) the attitude of the public. The finished product usually represents a compromise among the demands of all three.

Engineering requirements may be either flexible or rigid. On flat terrain the exact location of a standpipe or elevated tank may not be too important, whereas on rugged terrain the location may be the paramount consideration—indeed, choice may be restricted to one point.

Considerations of cost must include both initial and operating costs. Both must be within a range that the public is willing to pay through water rates and taxation.

In addition to general public acceptance, the approval of residents of the immediate neighborhood must be obtained. A facility too Spartan in appearance causes objections from the neighborhood, whereas too lavish a treatment invites the criticism that public funds are being wasted on unnecessary frills.

There are several approaches to achieving a satisfactory balance among the three factors of engineering, cost, and public attitude. Research on new materials, designs, and methods can open up new engineering possibilities at lower costs. A good public-information program can sell people on the need for additional water facilities. One of the most useful tools for gaining public acceptance of the best combination of engineering and cost is good landscape treatment. It is usually preferable to other alternatives, such as change of location or redesigning of the structure.

Landscape design is inseparable from facility design. It does and should influence facility design, but is secondary in importance to good functional layout. A good overall design that takes landscaping requirements into account can, of course, simplify the job of the landscape architect. Current explorations in design which may find wider public acceptance include multi-colored asbestos roofs for flat-top underground reservoirs, and some new designs of ground level reservoirs and elevated tanks.

EBMUD Facilities

East Bay Municipal Utility District (EBMUD) is the second largest purveyor of domestic water west of the Mississippi River and operates, because of the terrain, one of the most complicated water systems in the world. It serves water to about 1,000,000 users.

In June 1960 the EBMUD maintained 186 water works facilities varying from small pumping plants to large filter plants on sites covering 20 acres or more. Sixty of these facilities were established within the last 10 years, and 23 within the last 5 years. Currently, 12 new structures are completed and awaiting landscaping. Ten other facilities are under construction. In addition, 154 future sites have been acquired or are in the process of acquisition. The great majority of these facilities are now, or will be, in residential areas.

Judgment in anticipating change is an important consideration in landscaping of a facility. A reservoir in cattle country today may be in a subdivision next year. As a practical approach, most structures are landscaped with a basic planting in anticipation of suburban development. Many such landscape designs are in two stages, an initial planting of trees with smaller dressier understory material to be added later when needed.

For the last 10 years EBMUD policy has been that landscaping of its facilities should be no more elaborate than necessary to present an acceptable appearance in harmony with the structure and in keeping with the general surrounding area. Some of the means available for the implementation of such a policy are discussed below.

Land Use Permits

There is a legal question as to the extent of local zoning control over public water utilities. In the interest of good public relations, however, EBMUD follows customary procedures in obtaining use permits, whether the facility is situated in unincorporated territory or in one of the thirteen cities within EBMUD boundaries. This in itself creates problems, as there is no uniformity in zoning regulations and procedures in the various jurisdictions.

Before 1955, requests for land use permits by EBMUD were handled internally by the department concerned on an informal basis, as no particular difficulties were encountered. By 1955, however, there was a growing emphasis on zoning by the various jurisdictions and by neighborhood associations. This, in turn, caused a change in EBMUD procedure. Land use permits were made a legal department function. Analysis of land use permits granted during 1955–60 shows a wide variation in objections received and in conditions imposed by permits. These objections were raised by planning commission staffs, neighborhood groups, or by both. Frequently EBMUD was supported against neighborhood groups by planning commission staffs. The objective of EBMUD's public relations program is, of course, to enlist the support of both groups.

As a rule, permits were routinely granted in less densely settled areas, with the proviso that the facility be landscaped by a licensed landscape architect in accordance with EBMUD standards. Sometimes the plans were subject to approval by a planning commission. There was a noticeable increase in the amount of landscaping requested during the 5-year period.

Basic Landscape Problems

Among the demands on the landscape architect's skill are beautification for its own sake, deadening of noises, and camouflaging of unattractive structures. In anticipation of an urban-renewal project, a recent permit for a parking lot included such conditions as a 5-ft-wide border planting of street trees, shrubbery, vines for the fence,

and interior islands of trees and shrubbery. These conditions were imposed by a planning commission staff. The area is presently residential and blighted in character. Another recent permit specified that the noise level at the edge of a pumping plant property should not exceed 56 db. The pumps used were of the submersible variety, and no trouble is anticipated. The condition satisfied a neighbor who may have previously experienced noise from an aboveground pumping installation or transformer bank.

The camouflage of unattractive structures is the most important landscaping problem encountered. A multimillion-gallon reservoir of conventional design is totally unacceptable to some neighborhood groups, particularly during the first few years. Eventually the foliage attains the height and density necessary to break up the lines of the structure. A 10-mil gal reservoir is equivalent in height to a six-story building containing more than 700 rooms each 15 ft square. Even a 1-mil gal reservoir—the height of a three-story building containing about 70 rooms—appears large to an adjacent homeowner.

One land use permit now pending involves a 1.5-mil gal reservoir located in a subdivision just starting construction. The reservoir will serve the lower portion of the subdivision. The local board of adjustment unanimously supported its planning staff in granting a land use permit to EBMUD. Engineering requirements are very rigid at this site. At considerable extra cost, EBMUD had agreed to move the reservoir somewhat into the hill, erect a berm for partial screening, and transplant some larger trees on sides exposed to critical view. These proposals, however, were not enough for the landowner and subdivider. The case was appealed to the city council, which instructed EBMUD to continue its efforts to find some way to gain public acceptance. EBMUD is still seeking that way.

High standards of engineering practice plus a difficult terrain combine to make site requirements for EBMUD reservoirs rigid. One hundred and fifty-four new sites have been selected, based on the flow line of conventional reservoir configurations, and have already been acquired or are in the process of negotiation. This fact makes public acceptance of aboveground structures of the utmost importance and lays special stress on landscaping as a means to that end.

Landscape Design

Space requirements for the landscaping of proposed EBMUD facilities are considered before the property is purchased. A site acquisition committee, composed of representatives of hydraulic design, public relations, land, engineering design, and landscaping design personnel, reviews all sites prior to purchase. Sites having an existing growth of trees or concealed from view by topography are chosen over equal alternatives. Effort is made in design and construction to save as much of this material screening as possible.

The thread of landscape design runs through the entire construction process from original acquisition of property to the final planting. As part of EBMUD's standard engineering procedure, landscape design requirements are given consideration along with functional requirements. A preliminary engineering design layout forms the basis for a preliminary landscape design, and both are thoroughly reviewed by future operating personnel

Fig. 1. Happy Valley Tank, Lafayette, Calif.

This planting of fast-growing Acacia trees is only 1½ years old. One-gallon stock was used.

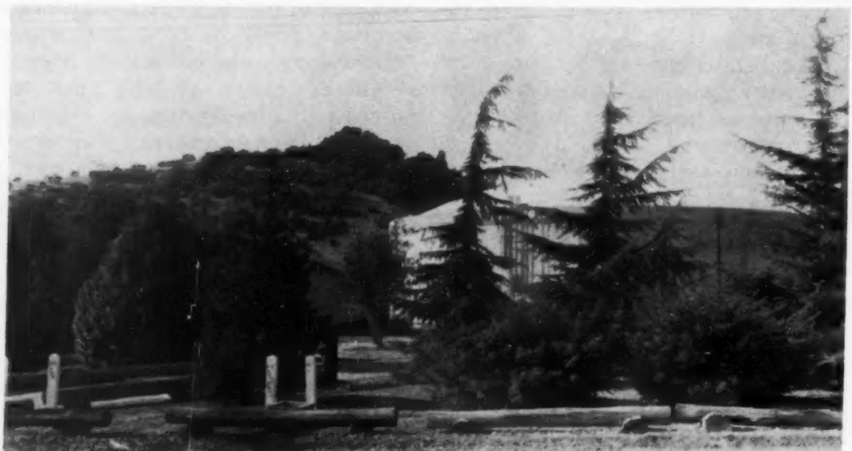

Fig. 2. Bryant Reservoir, Orinda, Calif.

The planting shown is 9 years old.

and by a landscape committee comprised of public relations, legal, and land division personnel before being submitted to management for approval.

Planting Techniques

Because of the need for rapid screening, EBMUD has used fast-growing species of trees, some of which, under good conditions, can reach a 20-ft height in 3 years from 5-gal stock. These include eucalyptus, acacia (Fig. 1), and poplar. They are backed up by more desirable species that can eventually be given dominance on the site.

The best sites for water utility structures are on solid rock. Such a site, unfortunately, affords difficult growing conditions. To gain the most rapid growth in the shortest possible time, topsoil is brought in for planting holes where necessary. A program of "forced feeding" is also undertaken in critical areas. Watering and fertilization schedules are set up in accordance with the requirements of the species. Such a program makes a decided increase in growth, but on some extreme sites growth rates are still slow. A constant search is being made for more adaptable species. Particularly promising are some recently introduced species of eucalyptus.

The use of vines to camouflage tank walls is again receiving attention. On some new reservoirs a vine planting area is designed adjacent to the ring of the tank wall. The underlying drain system of the tank has vertical risers at intervals in order that bluestone may be flushed through the drain system to prevent clogging from vine roots. At three previously constructed reservoirs redwood vine planter boxes were built adjacent to the tank wall. For the East Bay area, one of the best vines is the deciduous Virginia creeper.

Faster screening is also being sought through the use of larger planting stock. Most landscape maintenance personnel look with horror on the use of large top-heavy material on exposed windy sites, as it is subject to blowdown and breakage.

According to EBMUD experience, in a period of 3–5 years, 1- to 5-gal stock with well developed root systems will overtake and surpass larger stock 10–14 ft in height at planting. Nevertheless, more of the larger stock is being used. The EBMUD is also letting a contract to move pine trees 20–25 ft in height from its own watershed plantations to reservoirs constructed nearby (Fig. 2).

Preplanting of Future Sites

The acquisition of some 154 future facility sites has been mentioned. A few of these sites lie in natural woodlands or are hidden by steep topography. Most of them, however, are on barren ridge tops or side hills.

The site acquisition committee recommends whether each site should be preplanted—that is, planted with trees now in anticipation of future construction. If such construction is 8–10 years hence, the structure can then be placed in a landscaped setting.

When preplanting is done without pre-excavation, an additional 20 ft of property on each side is acquired to afford construction space when the structure is built. In some cases additional space is not available—for example, in subdivision areas, on narrow ridgetops adjacent to roads, and so on. Where earthwork is to be extensive, the site may be excavated prior to

Fig. 3. Happy Valley Tank, Orinda, Calif.

Monterey pines, 20 ft high, are being transplanted for screening.

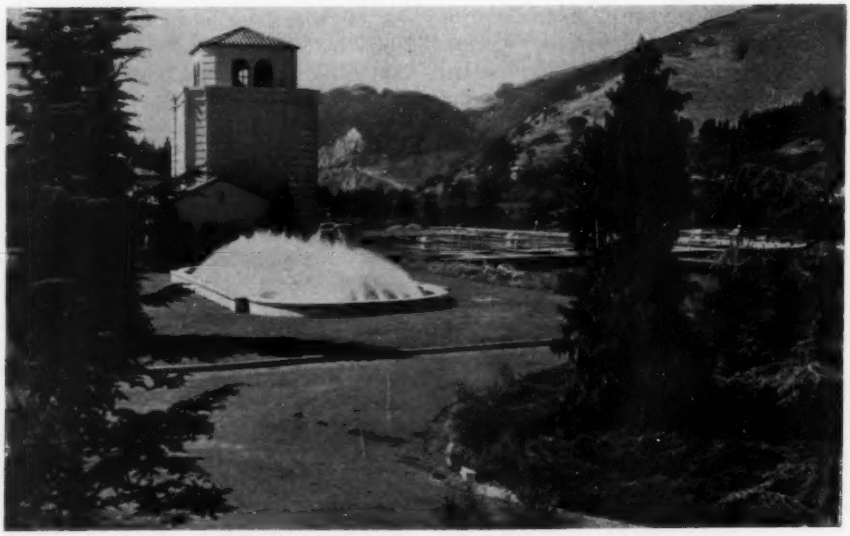

Fig. 4. Upper San Leandro Filter Plant, Oakland, Calif.

Shown are the aerator and chemical storage tower in attractively landscaped surroundings.

the preplanting. With steadily rising construction costs, such pre-excavation is economically justified. There is a calculated risk that plans may be changed before the structure is built, but in most cases the risk is minimum.

Neighborhood Participation

All future EBMUD facility sites, even in remote areas, are marked by an attractive sign, which gives notice of the planned construction to present and future neighbors. As landscape design plans reach the formative stage, neighbors and neighborhood associations are invited to offer suggestions. Usually there is no problem at this point. Interest grows as construction proceeds. Through this interest good suggestions are received and maintenance cooperation is often volunteered. If the area has a recognized landscaping mode, then it is followed in the design. Vandalism is also held to a minimum when there is neighborhood participation.

Cities, too, often participate. Several areas are used for parks, rose gardens, golf ranges, and playgrounds. These are maintained and operated by the cities, although EBMUD must, for various reasons, retain ownership.

Maintenance

No discussion of the landscaping of water utility structures is complete without a mention of maintenance. The manner in which properties are maintained has a major influence on public acceptance of future structures. Previously constructed facilities are pointed to either with pride or with derision in hearings involving future construction.

EBMUD properties are divided into four classes of maintenance levels. These levels grade upward from Class D, which are primarily structures or rights of way in industrial areas and have no landscaping at all. Class C properties are planted with trees but maintained only for fire safety. Class B properties are in average neighborhoods and Class A properties are in highly landscaped residential areas. Class A also includes administrative office buildings. Costs vary from $100 to $900 per acre annually, depending on the level of maintenance. With more than 270 acres presently involved, plus growing acquisitions, the total spread in annual maintenance cost can be considerable. Any question of maintenance level is resolved by EBMUD's landscape committee.

Means are constantly sought to lower maintenance costs. Chemical weeding and mechanical irrigation are practiced. Land parcels not actively needed, such as rights of way, are leased to an owner of adjoining property on a permit system, the permittee being responsible for maintenance.

Every operation is scheduled by means of a card system on a master scheduling board. Only through this means can the grounds supervisor maintain control over a complex operation. On completion of a project the card becomes a permanent record, from which costs may be determined for any property at any time for any phase of the maintenance work.

Conclusion

Public opinion is one of the three main considerations in the construction of any water utility structure—particularly where engineering requirements are rigid—for it usually determines the kind of landscaping that is desirable and feasible. It can almost be stated as a theorem: "the degree of landscape development is directly proportional to the rigidity of engineering

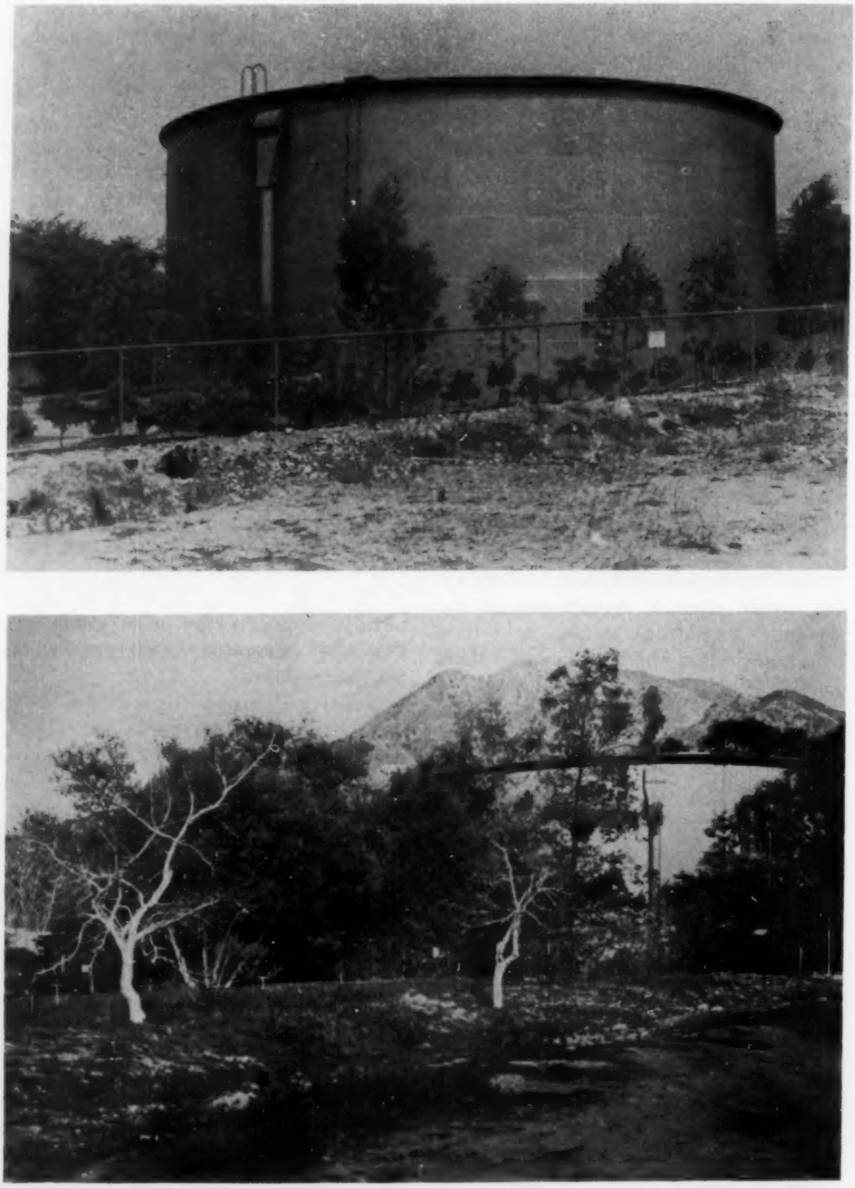

Fig. 5. Los Angeles' Irma Ave. Tank, 1955–60

Shown is the screening achieved in only 5 years.

requirements and to the level of public interest in the project."

Sometimes the desire for an immediate effect, may force the use of methods and procedures which the professional landscape architect does not welcome. Plants with better long-range characteristics may give way to inferior species with a quicker growth rate. Larger planting stock with poor root systems may be used instead of smaller stock with a better long-range growth potential.

Rapid changes in population are forcing adjustments in thinking for which there may not always be adequate precedents. The challenge facing the landscape architect of water utility facilities today is tremendous. After the resources of engineering and public information have been exhausted, it is up to him to fill the gap and win final public acceptance. This is not a small task.

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The best way to bring about a realization of the highest aims of landscape development for water utility structures is to engage a qualified landscape architect who possesses a visual imagination and an understanding of form, color, texture, balance, and repetition. It is such a man's responsibility to achieve an aesthetically pleasing but functional design, with simplicity and restraint. One of the complexities of landscape design is obtaining an integrated whole, in which landscape and architectural structures both participate and complement one another. One must recognize the interdependence of structure and site and take every advantage of the ground, to produce a result that is both beautifully composed in three dimensions and functional.

Apart from aesthetic considerations, the beautification of water system structures tends to increase the property values in the neighborhood, thus increasing the taxable value of the land. This principle is one reason for the encouragement of citizens to beautify their property, and it has been proved time and again.

The landscaping needs and requirements for any particular water utility structure are governed primarily by: (1) the type of structure; (2) the neighborhood in which it is placed; (3) its utilitarian function; (4) the type of soil around it.

Although poor soil can, and often is, replaced or enriched to support plant growth, it is far less expensive—and creates a greater challenge to the designer—to find plant material which naturally thrives in poor soil, rocky ground, or arid terrain. This is the point of view held by the Los Angeles water utility. Exceptions are sometimes made when the plant material can serve a dual purpose of creating color masses of foliage, flowers, or berries which can also be utilized for decorations at civic functions.

The use of showy annual and perennial flowers for landscaping water utility structures has been exemplified by the practices of Portland, Ore., water department and the San Francisco water department. The author has also seen the use of flower borders and beds, to a lesser degree, by the water departments of Seattle, Vancouver, Victoria, New Orleans, Dallas, and El Paso.

In the Los Angeles water system, the landscape design of utility structures, especially in residential areas,

consists chiefly of lawns, ground covers, shrubs, and trees. As a general rule, the ground is molded in a plastic pattern on the site to conform to the utilitarian features, such as driveways, walks, and parking areas.

Tanks

In Los Angeles, storage tanks are partly concealed by a surrounding berm, often 10–12 ft high. These berms are then planted with tall fast-growing trees and shrubs to conceal the tank as rapidly as possible (Fig. 5). The ground between these plantings is often planted with fast-growing ground covers.

In residential areas such ground covers may consist of California poppies, lupines, and sweet alyssums, or African daisies. All of these flowers are self-perpetuating, readily reseed, and thrive in various climates. Once established, they will, to a large degree, prevent soil erosion during heavy rains, if they are established before the rainy season. Trees and shrubs out of containers may be planted any time of the year, provided that they receive regular watering until properly established.

In the Los Angeles climate, the seeds of the herbaceous flowering ground covers are preferably planted in September or October, just before the rainy season, on a ground that has been flocculated. The seed does not necessarily have to be raked in if the ground is loose. The subsequent waterings by sprinklers or rain should move fine soil particles over the seeds and thus protect them from the drying effects of the sun. The rate of application of these flower seeds is 8 lb/acre. On uncultivated areas it is most important that the seed is planted before the first rain, so that it will have an even chance with the grasses and weeds, which are certain to establish themselves with the rainy weather.

Buildings

On buildings it has been the practice to accentuate the design and bring the new landscape into closer relationship and scale by judicious use and spacing of relatively large broad-leafed trees, pine trees, palms, and shrubs. Subordinate masses of smaller-sized plants tie the whole ensemble together. The shrub and tree plantings are then set off by expanses of lawn or ground covers. On the more conspicuous locations, touches of color are added by the careful introduction of annuals or perennial flowers or dwarf flowering shrubs.

Recently a greater use has been made of shrubbery and herbaceous ground covers because they require low maintenance and little replacement. This has not always been borne out, however, and many horticulturists and landscape architects disagree as to the economic and aesthetic merits of ground covers. It is the author's opinion that a combination of both grass and ground cover may perhaps be, from all aspects, the best compromise. The chief disadvantage of ground covers lies in the fact that obnoxious and hard-to-control weeds may establish themselves, whereas on a regularly mowed turf they would be easily eliminated. On the other hand, the many insects and diseases that attack turf grasses and the subsequent need for perpetual control may be a consideration.

In some areas, under certain conditions the use of textured and colored rock in previously sterilized soil has been found both economical and acceptable in appearance. Great care must be exercised in the application

of any soil sterilant, as permanent damage to existing or proposed plantings can result from improper or careless use.

Watering of Plants

Maintenance costs can be minimized by the use of automatic or hand-operated sprinkler systems which provide an adequate coverage for all plants. In large areas, especially where water pressure is low, or if only infrequent watering is required because of the type of vegetation, revolving, removable sprinklers may be used. Sprinklers are, in general, far more satisfactory than hand watering.

No matter how well the grounds have been planned and constructed, their ultimate appearance depends entirely on the degree of care, especially the amount of water, the plants receive.

Watering is the greatest art in gardening. To know when, how, and how much to apply is an art that some people never acquire. Today, soil tensiometers practically eliminate guessing, but it will be a long time before they can be used on large areas with diversified vegetation. Some plants require more moisture than others, and one must take differences in soil structures and moisture retention variables into account.

Fig. 6. Upper Franklin Reservoir

The conifer planting along the shore has made this reservoir popular for motion picture and television location shots.

Reservoirs

The landscaping of reservoir sites should include a large percentage of plants belonging to the coniferous group, such as species of pine, juniper,

cedar, thuja, yew, cryptomeria, podocarpus (Fig. 6). These types of plants and their many species have a tremendous geographical and climatic range, are readily obtainable or propagated, and, in most cases, are quite tolerant of a great variety of soil conditions. The needles of these conifers have relatively little effect on the biosis or taste of the water, and they are recommended by sanitary engineers. Broad-leafed plants which are drought-tolerant and require little maintenance may also be an aesthetic and functional asset in the overall landscape. On reservoir dams the state of California prohibits the planting of large trees. The apparent reason for this is that their extensive root systems may impair and weaken the dam structure. In place of trees mass plantings of low-maintenance native and exotic shrubs are used on earth-fill dams. These hold the soil and reduce weed growth.

Pumping Plants

Pumping plants are more frequently located in residential areas than are reservoirs. These buildings should be given a contemporary landscape and architectural treatment in keeping with that of the neighborhood. In the design of the grounds, the use of small geometrical flowerbeds or many isolated shrubs should be avoided, as such frills greatly increase the necessary maintenance. Flowering trees and shrubs may well be used with discretion. In a warm climate, palms and subtropical plants would be quite in

Fig. 7. Westridge Pumping Plant, Los Angeles

The use of a stone facade and attractive pine plantings makes this pumping plant into an aesthetically pleasing structure.

order. Their need for little care and maintenance and the fact that they cause no litter problem make them very desirable.

In California, substitutes are being used for the conventional grasses with either ground covers of various types or with some of the hardier, more disease- and insect-resistant stoloniferous grasses, such as the centipede grass (*Eremochloa ophiuroides*), St. Augustine grass (*Stenotaphrum secundatum*), and Kikuyu grass (*Pennisetum clandestinum*)—or, in shady areas as well as in full sun, the lily turf (*Liriope muscari*) or Mondograss (*Ophiopogon jaburan*).

There are several species of Zoysia grasses which merit consideration in warmer climates. Also, a number of excellent new strains of the Bermuda grass (*Cynodon dactylon*) recommend themselves highly because of their hardiness, fine, green texture, and tendency not to turn brown in winter as readily as the older variety. All of these grasses may be easily propagated by cuttings or stolons, rather than by seed. It would be remiss not to mention the Dichondra lawn which has great advantage in combination with other grasses, such as Bermuda grass.

Another fine turf substitute is the low-growing creeping lippia (*Lippia canescens* or *repens*). It will not tolerate too much cold and has, from the point of view of hazard to personnel, the disadvantage of attracting honey bees in great numbers.

Fig. 8. Well Lot in Residential Section

Trees and shrubs completely mask this otherwise uninteresting, if not unattractive, well lot.

Office Buildings

The landscape treatment of the main building of the water utility should, of course, be the culmination of all of its beautification program. Many large utilities employ excellent landscape and architectural treatment for their office buildings; particularly note-

worthy is Tacoma, Wash., which has, perhaps, one of the best and most appropriate design programs. Not only is Tacoma's water utility office building strikingly modern, but the grounds around it have been beautifully designed, incorporating water features set off by verdant lawns. This may serve as an example for others to follow.

The general trend today, not only in the United States, but also in some European countries and Mexico, is to beautify existing public utility structures by comprehensive landscape development and the planting of trees wherever they fit into the design.

The use of fountains, lakes, and other water features has a favorable psychological effect upon the public. Such features could become an expensive maintenance problem in warmer climates, especially if they are accessible to the public. In the placement of pools or fountains, good judgment should be exercised in their placement with relation to traffic lanes, such as walks and roads. A water feature may at once become an attractive hazard and a depository of trash. In some locations, the cost of posting a guard would have to be considered to insure against public liabilities and vandalism. The periodic, perhaps weekly, draining and cleaning of fountain or pool and treatment with copper sulfate to prevent the accumulation of green algae are cost factors that must not be overlooked. A feature designed for beauty could become psychologically and aesthetically unattractive if it developed a green scum and became littered with paper and cans.

Conclusion

All water utilities should make an earnest effort to beautify and landscape all of their structures and facilities that are in the public view. Landscaping should be placed in the hands of competent landscape architects who are able to correlate the grounds to the structure. Such men know what type of plants best serve the aesthetic and functional needs. They will also design the grounds not only to appear attractive and complement the structure, but also to require the least amount of care.

Finally, good maintenance practices must be followed to insure a clean, orderly, and attractive appearance at all times.

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Status of Operator Certification and Training, 1960

W. McLean Bingley

A paper presented on Nov. 3, 1960, at the Chesapeake Section Meeting, Washington, D.C., by W. McLean Bingley, Public Health Engr., State Dept. of Health, Baltimore, Md.

In 1958, AWWA and the Conference of State Sanitary Engineers (CSSE) appointed a joint committee to study and report on all phases of certification and training of water utility personnel. In 1960, representatives of WPCF were selected to join the two groups in reviewing the problems. Thus, when a final report is issued on the subject, it will concern both water and sewage utility personnel.

Activity During 1952–60

An interim report of the joint committee was submitted at the 1960 AWWA Annual Conference in Bal Harbour, Fla. It was recommended that the committee remain active in order that it might develop more detailed information on certification and training and prepare uniform plans for operator certification, one plan for a voluntary program and the other for a legislative act. It is interesting to note that the report showed that as of May 1960 water works operator certification or licensing was required by state law in ten states and by voluntary action in 25 states. Colorado has been added to the states with a voluntary program since the report was written. A study of the status of operator certification made in 1952 indicated that at that time seven mandatory-certification programs existed and sixteen voluntary plans were functioning. It is thus apparent that during the 8 years 1952–60 ten additional voluntary plans were developed and three of the older voluntary plans became, or were replaced by, mandatory ones.

As the interim report of the joint committee contains considerable information on existing certification, licensing, or registration programs, it does not seem necessary to consider the details of these plans here.

Evolution of Mandatory Programs

The general opinion of the committee is that it is advisable to promote a mandatory-registration plan by legislative action. This could be done in a manner similar to that in which legislation for registration of professional engineers has been developed in most states. In five of the ten states now having mandatory operator certification, voluntary plans were in existence for some years before they became compulsory. It is believed that any plan of this sort should be developed by those who will be certified—the plant operators—with the assistance of state agencies, consulting engineers, plant managers, and others who are interested in obtaining more effective operation of water treatment plants; no such plan should be forced on operating personnel by a public agency, such as a state health department. Carrying out a successful voluntary program to

which a majority of the operators subscribe is the best way to convince a state legislature or management of the desirability of rigid requirements for operating personnel and of not permitting treatment plants to be operated by persons who are not fully qualified.

A most important part of any operator certification program is the educational opportunities offered to the operator, not only in preparing for certification, but also in helping him to improve and maintain the quality of the water distributed by his system.

There is no uniform training program or curriculum which would apply generally throughout the United States, and it is not likely that any such standard curriculum could be developed. Each state has its own peculiar problems which need particular emphasis.

State Programs

Many of the states are conducting short courses of 3–5 days' duration. These are generally sponsored by the state health department and the state university. The topics selected for discussions are often more promotional than educational. Some of the short courses have admittedly developed into conferences rather than sessions of real educational merit. Several states, particularly Colorado and Virginia, hold a seminar type of meeting intended primarily to supply current information on design topics to consulting engineers and other design officials. Correspondence courses are offered in a few states, but from the information available, these courses do not seem to have been completely successful. The difficulty seems to be in developing the course textbooks and presenting useful information in such a way that it can be absorbed through correspondence.

Some states, such as Arkansas, hold monthly meetings in each of the state health department's administrative districts. These district meetings continue the short-course material and are primarily aimed at giving information that will prepare the operator for the state licensing examination now required by law. It is interesting to note that Arkansas also has found the *Manual for Water Works Operators,*[1] produced by the Texas Water and Sewage Association, to be most valuable as a textbook for its annual short course. Several other states also utilize this excellent manual.

In Colorado the short school lasts for a week and contains four separate courses; certain lectures are attended jointly by water and sewage plant personnel, when the subject is applicable to both. The University of Colorado Extension Division has a correspondence course called "Elements of Plant Arithmetic." Few have taken advantage of it, however, probably because the title is somewhat misleading (the course also includes elementary chemistry) and because of the failure to publicize its availability. In Iowa, the district schools hold a 2-hr session one night a week for 9 weeks, as part of a mandatory operator certification program. Kansas has conducted water and sewage works schools since 1920 and has attempted to interest management by holding a separate utility management session for the past 2 years. Although there is a demand for training in some of the manual operations connected with treatment plants, it has not yet been decided whether the demand could be satisfied by six annual district meetings or whether a specific school should be set up.

There does not appear to be any great difference in the methods used in the various states for operator edu-

cation. It is apparent that there is a real need for developing educational programs rather than permitting the short course to deteriorate into a mere conference meeting which actually does not provide the plant operator with information he needs to improve the operation of his treatment plant.

Probably the most effective educational program in the field today is that conducted in New York. The water plant operator is certified by the state health department before he is employed by a municipality or privately owned utility. The New York State Sanitary Code requires that "approved courses of instruction" shall be available for Grade III and Grade IIB plant operators. Grade II courses are handled by the state health department's central office training section under contract with colleges and universities in the state, such as Cornell, Rensselaer Polytechnic Institute, and New York University, and require a 2-week residence of study. Grade III courses are conducted under the guidance of the health department's five regional engineers at such times and places as the regional engineer feels are necessary. These courses are of 3 days' duration and a manual and examinations are developed by the central office's training section to insure uniformity of training throughout the state. The New York program, of course, is a result of a legislative act that requires that the state health department approve plant operators.

Inadequacy of Programs

It appears that even though short courses have been conducted in many states for many years, methods of selecting course material and presenting it are inadequate. Educational activities could be improved through consultation with the staffs of the state universities to determine what suggestions professional teachers could offer for the education of plant operators. In most areas the local health department, AWWA section, and water and sewage works operators association are attempting to prepare curricula and utilize, as best they can, members of the technical staff of the health department, experienced water plant operators, and manufacturers' representatives as instructors. Perhaps the assistance of professional instructors at the state universities would help to improve the content of the courses and provide better instructing staffs. Some of the states have indicated that there is no lack of willingness, on the part of engineers or operators, to present lectures, but that many expert people simply cannot teach.

The problem of education is not limited to plant operators. Design engineers, the manufacturers' representatives, engineers representing state regulatory agencies, managers, and administrative officers all need to know something about plant operation. All have experienced the results of a design made by someone who has never operated a plant or has little concept of the operator's problems. It is possible to design a basically very good plant and still make the operating problem extremely difficult or inefficient. There can be no question that everyone in the water supply profession could readily profit from a knowledge of plant operation. Therefore, the author believes that short-course curricula should include programs of value to administrative and design personnel as well.

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Electrophoretic Studies of Turbidity Removal by Coagulation With Aluminum Sulfate

A. P. Black and Sidney A. Hannah

A contribution to the Journal by A. P. Black, Research Prof. of Chemistry & San. Sciences, and Sidney A. Hannah, Research Asst., both of Dept. of Chemistry, Univ. of Florida, Gainesville, Fla. *The investigation was supported by Research Grant RG-4516 from the National Institutes of Health, USPHS.*

CLAY constitutes the most commonly encountered turbidity that must be removed from industrial and municipal water supplies. This turbidity is generally coagulated with alum or ferric salts, followed by sedimentation and filtration to remove resulting flocs. Difficulties are often encountered in coagulation because of variations in the composition of the water and the amount of suspended material to be removed. Although the effects of these variables have been the subject of research for many years—research to determine the mechanisms by which coagulation proceeds, in order to allow a greater degree of control over treatment processes—the behavior of a given water is not always predictable.

Numerous articles have been published on the theory of the action of metal coagulants. A large number of these have been listed in a comprehensive bibliography on coagulation prepared by R. F. Packham of the British Water Research Association.[1] It has been shown that the coagulation of water may be affected by the type and amount of turbidity present, cations and anions in solution, size distribution of particles, pH, coagulant type and dosage, and alkalinity and salinity. Any experimental conditions must include these factors, and any departures from the given conditions must be evaluated as to the overall effect on coagulation.

Zeta Potential

One important factor affecting coagulation is the negative zeta potential, often referred to as the charge, that is associated with natural clay particles suspended in water. The zeta potential, which causes mutual repulsion of the clay particles and may prevent their coming together to coagulate, is modified by the ionic constituents in the supporting water medium. Some workers in the field have reported that the best removal of turbidity occurs where the zeta potential has been neutralized. Others have found that good coagulation occurs prior to complete neutralization.

Black[2] and Langelier and Ludwig[3,4] believed that the zeta potential was neutralized by tripositive aluminum or ferric ions. Langelier and Ludwig also proposed that a small amount of excess alum was necessary to hydrolyze and

serve as a binder material to tie the flocs together. Mattson,[5] on the other hand, concluded that the hydrolysis products were more important in neutralizing the zeta potential. He also found that the zeta potential did not have to be neutralized for rapid coagulation to take place. Pilipovich and others,[6] using electrophoretic techniques, found the hydrolysis products of alum to be stronger coagulating agents than the tripositive aluminum ion.

The primary purpose of this investigation was to study the relationship of particle zeta potential and coagulation in dilute clay suspensions as the alum dosage and pH were varied. In addition, the effects of polyelectrolyte coagulant aids on zeta potential and on coagulation were determined as a possible aid to a better understanding of the mechanisms of coagulation.

Variable pH Series

In the variable pH series, three clays having low, medium, and high base-exchange capacities, respectively, were coagulated with alum as the final pH was varied from 3 to 10 with HCl or NaOH. Alum dosages used were 0, 5, 15, and 100 ppm. Mobility values of the particles and residual turbidities were plotted against pH and may be directly compared.

TABLE 1

Base-Exchange Characteristics of Clay Suspensions

Type of Clay	Base-Exchange Capacity *me/100 g*	Clay Concn. in Suspension Coagulated *mg/l*
Kaolinite 4	8.7	65.8
Fuller's earth	26.5	72.2
Montmorillonite 23	115.0	65.6

TABLE 2

Clay Turbidity and Alum Dosages in Microequivalents

Type	Base-Exchange Capacity *μe/l*
Kaolinite 4	6
Fuller's earth	19
Montmorillonite 23	75

Alum

Dosage *ppm*	Base-Exchange Capacity *μe/l*
5	45
15	135
100	900

The three clays used were kaolinite 4,* montmorillonite 23,* and fuller's earth.† Preliminary sample preparation consisted of crushing and ball milling, followed by the mixing of 1 per cent suspensions of the particular clays in demineralized water. After being left to stand overnight to allow hydration, each suspension was slowly passed through a glass column containing a cation-exchange resin‡ in its sodium form to replace the exchangeable cations of the clay with sodium ion. This process, developed by Lewis,[7] was used to give a more uniform suspension, allowing greater precision of measurement, and to promote exchange reactions with alum or its hydrolysis products because of the high zeta potential associated with the sodium form of clay. The 1 per cent

* Obtained from Ward's Natural Science Establishment, Rochester, N.Y.

† Floridin, a processed Florida fuller's earth, manufactured by Floridin Co., Tallahassee, Fla., was used.

‡ Nalcite HCR, a product of Nalco Chemical Co., Chicago, Ill.

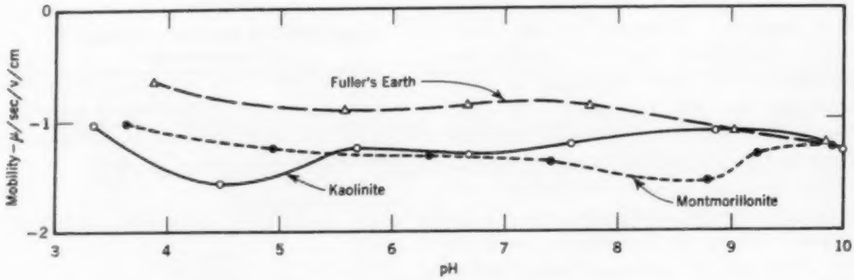

Fig. 1. Mobilities of Clays Without Alum

A total of 50 ppm $NaHCO_3$ was added to the suspensions before the pH was adjusted with 0.1N HCl or NaOH.

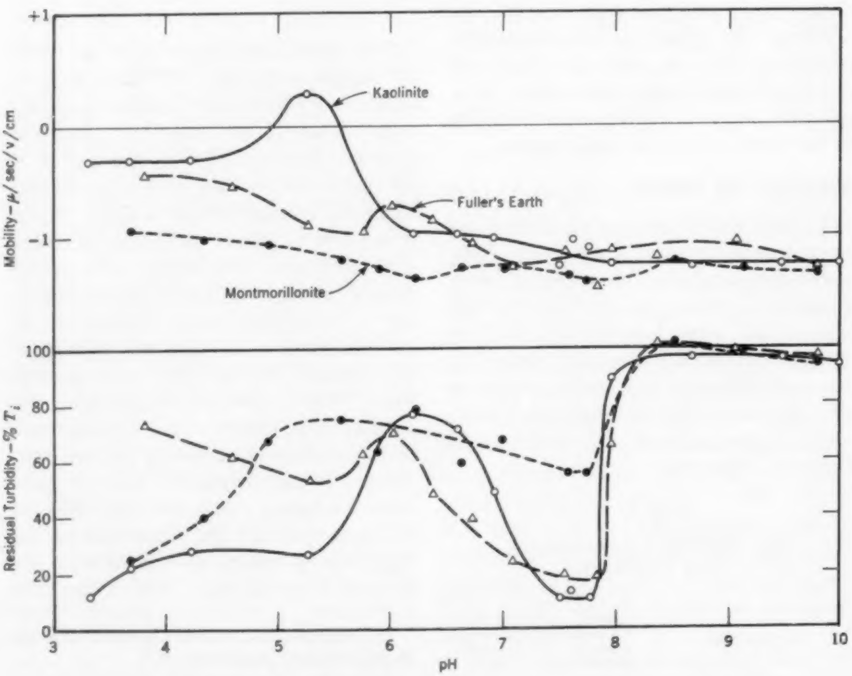

Fig. 2. Coagulation of Three Clays With a Dosage of 5 ppm Alum

Sufficient HCl or NaOH was added to each suspension before coagulation to give the desired final pH.

sodium-clay suspensions were diluted with demineralized water to form the working suspensions for jar tests and mobility measurements. The amount of clay in the suspension was determined by evaporation of an aliquot to dryness and weighing of the residue. The gravimetric turbidities of the clay suspensions used and the base-exchange capacities of the three clays, as determined by the ammonium acetate method used in soil analysis,[8] are shown in Table 1; the base-exchange capacities of the suspensions, as calculated from the residue weights, are shown in Table 2.

Sodium bicarbonate was added to 2-liter samples of working suspensions to give a concentration of 50 ppm $NaHCO_3$. Sufficient HCl or NaOH was then added to give the desired final pH. One-half the suspension was mixed with the proper alum dosage and saved for mobility tests; the remainder was coagulated on a standard jar test machine. The jar test procedure included a 2-min rapid mix, 30-min slow mix, and exactly 10-min settling. At the end of the settling period, a sample was drawn from just under the surface of the water by an apparatus patterned after Cohen's.[9] The percentage transmittance of this sample was measured by a colorimeter * and converted to turbidity units by means of a curve prepared with standards measured on both the colorimeter and the Jackson candle turbidimeter. The pH was measured with a pH meter.†

Particle mobilities were determined by electrophoretic measurements in the Briggs cell, with the use of the apparatus and techniques described by Pilipovich and others.[6] Because the zeta potential is directly proportional to mobility, and small undeterminable changes will occur in the viscosity and the dielectric constant, the particle charge will be reported in terms of mobility. An approximate zeta potential in millivolts may be obtained by multiplying the mobility value by 13.

The effects of pH on mobility in the absence of alum are shown in Fig. 1. The clays remained negatively charged throughout the pH range, although the negative mobility decreased near pH 3.0 because of the increasing hydrogen ion concentration. Turbidity reduction was negligible without alum.

The effects of pH on mobility and coagulation with 5 ppm alum are shown in Fig. 2. In Fig. 2, and in the figures following, residual turbidities, which were determined optically, are expressed as percentage of the initial transmittance, T_i. The dosage of 5 ppm alum was equivalent to 45 $\mu e/l$ (Table 2), nearly eight times the exchange capacity of the kaolinite and more than twice the exchange capacity of the fuller's earth. Charge reversals, however, occurred only with the kaolinite. This charge reversal at pH 5.3 is in good agreement with Mattson's [5] value of pH 5.2 for maximum reversal of zeta potential. Kaolinite coagulated well in two regions: one region at low pH, marked by low negative mobilities; and another near pH 8.0, where mobilities are more negative. The mobility curve located the acid zone of good coagulation but gave no indication of the existence of the alkaline zone of best coagulation. The fuller's earth showed good coagulation in the same alkaline

* Lumetron Model 450, made by Photovolt Corp., New York, N.Y.

† Beckman Model G, made by Beckman Instruments, Fullerton, Calif.

zone, but coagulation was poor in the very acid region. The mobility curves for the latter clay did not identify either zone of good coagulation.

In the next series of jar tests, a dosage of 15 ppm alum, or 135 μe/l (Table 2), was used. This was 22 times the exchange capacity of the kaolinite and 7 times the exchange capacity of the fuller's earth, but less than twice the exchange capacity of the montmorillonite. It will be noted (Fig. 3) that the charge on both the kaolinite and the fuller's earth was reversed over a range of almost three pH units, from pH 4.5 to about pH 7.5. The charge on the montmorillonite was reduced to a low negative value below pH 5.0, after which it became increasingly negative. All clays exhibited a zone of poor-to-fair coagulation between pH 3.5 and 4.5, which was followed by a wide zone of very poor or no coagulation between pH 4.5 and 7.5. With both the kaolinite and the fuller's earth, this pH zone of no coagulation coincided exactly with the pH zone of charge reversal. All three clays exhibited optimum coagulation at pH 7.5–8.2, but no indication of the existence of this optimum zone can be inferred from any of the

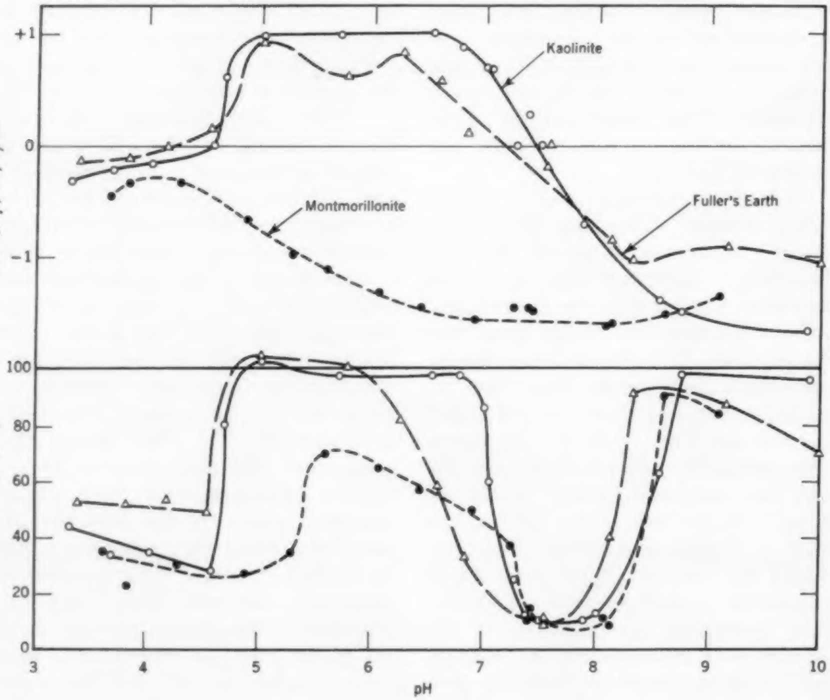

Fig. 3. Coagulation of Three Clays With a Dosage of 15 ppm Alum

All three clays exhibited optimum coagulation at pH 7.5–8.2.

mobility curves. The acid zone of poor-to-fair coagulation for the kaolinite and fuller's earth was marked by nearly neutral particles. In the narrow zone of optimum coagulation, pH 7.5–8.2, all particles were negative, the montmorillonite being the most negative of the three.

dosage reversed the charge on all clays (Fig. 4). The pH zone of charge reversal was narrowest (pH 4.5–6.5) for the montmorillonite and widest (pH 4.5–8.2) for the kaolinite. It is of great interest to note that the point of first charge reversal, at about pH 4.5, is the same for all clays, and

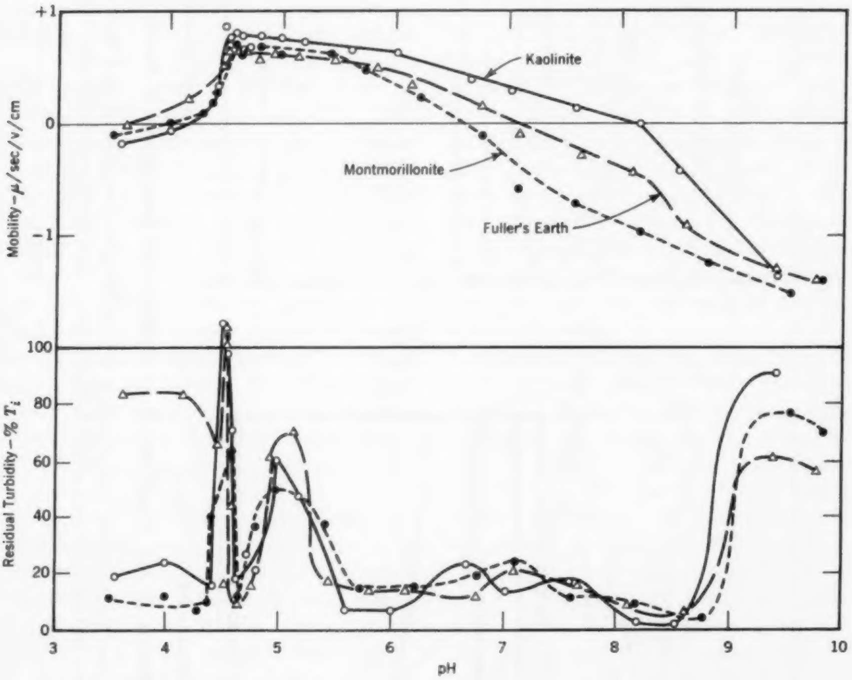

Fig. 4. Coagulation of Three Clays With a Dosage of 100 ppm Alum

The 100-ppm dosage reversed the charge on all three clays.

In the third series of jar tests, a dosage of 100 ppm alum equivalent to 900 μe/l (Table 2) was used. This dosage was 150 times the exchange capacity of the kaolinite, 47 times that of the fuller's earth, and 12 times that of the montmorillonite. As could be predicted from previous data, the the same as was found for kaolinite and fuller's earth with a dosage of only 15 ppm alum. It is also most interesting to note that dosages of alum in microequivalents per liter, which represented very large excess dosages in terms of the exchange capacities of both the kaolinite and the fuller's earth, did not

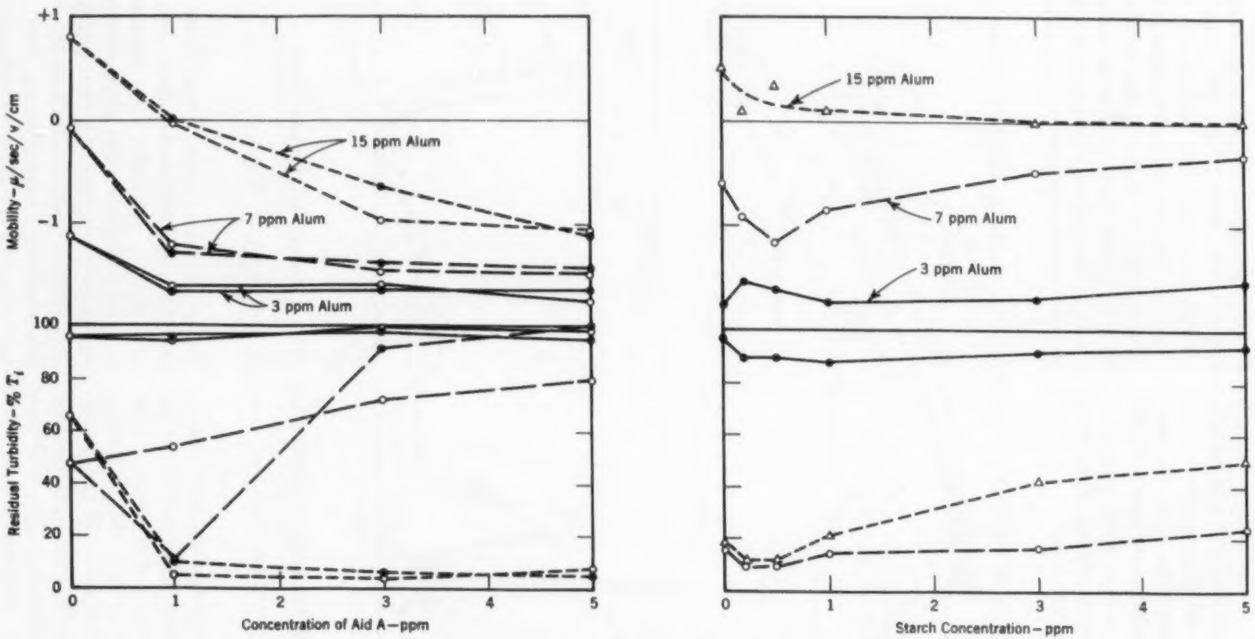

Fig. 5. Effects of Aid A and Starch on Mobility and Coagulation of Kaolinite

The curves on the left represent particle mobilities and residual turbidities after coagulation of a kaolinite suspension with alum and Aid A. Solid circles indicate that the aid was added before alum; open circles, that the aid was added after alum. The curves on the right show the effects of starch, which was added 2 min after the alum.

make the floc particles any more positive than did the very much smaller dosage of 15 ppm alum.

Good coagulation occurred over a wide pH range, with the exception of two narrow regions centered at pH 4.5 and pH 5.1. It is evident that these zones of poor coagulation, which were reproduced for all three clays, must be caused by some sensitive mechanism that is not reflected in mobility values.

In general, it may be said that the pH range covered by the zone of charge reversal increased with alum dosage for a particular clay and decreased with increasing base-exchange capacity for a given alum dosage. Best turbidity removal occurred between pH 7.5 and pH 8.75, in a region of negative particle mobility, rather than at the point of charge reversal, the optimum pH value increasing with alum dosage. An amount of alum equivalent to several times the base-exchange capacity of the clay present had to be added for charge reversal to occur, although lesser amounts give good coagulation.

A similar series of tests were carried out by use of 50 ppm NaCl in the suspensions instead of 50 ppm $NaHCO_3$. The results obtained essentially duplicated those shown with $NaHCO_3$ for the alum dosages of 0, 5, and 15 ppm. For the 100-ppm alum dosage, however, the mobility curves were reproduced, but the zone of poor coagulation at pH 5.1 was not present. The montmorillonite did not show either zone of poor coagulation at pH 4.5 and 5.1. Coagulation was thus changed by the anions present without affecting the particle charge.

These results may be interpreted as supporting Langelier's binder theory of the mechanism of coagulation of clay suspensions. Adjustment of pH with HCl and NaOH gave the same type of coagulation curve as Langelier obtained by varying the alum dosage, thus changing the pH by hydrolysis. The best removal of turbidity occurred near pH 8.0, where the maximum amount of hydrous oxide should be formed to serve as binder material. Gayer and others [10] found the isoelectric point of aluminum hydroxide to be pH 7.7; Larson and Buswell [11] found the isoelectric point of alum floc at pH 8.2. Collins and others [12] found the isoelectric point of floc from $AlCl_3$ to be pH 9.0; the isoelectric point of floc from $Al_2(SO_4)_3$ or from $AlCl_3$ with added SO_4^{--} was at pH 7.5. The authors' results show the isoelectric point of alum floc at pH 8.2–8.4. The isoelectric point is said to represent the minimum solubility for such an amphoteric hydroxide.[10]

At higher pH values, coagulation is poor, because the hydrous oxide is soluble. At lower pH values, other hydrolysis products may not serve as effective binders, although they are adsorbed on the particles and affect the particle charge. Below pH 4.5–5.0, coagulation is probably the result of neutralization of zeta potential by Al^{+++} and H^+, inasmuch as insoluble binder material should not extend through this region with the low alum dosages employed. Good coagulation throughout the intermediate pH region by use of 100 ppm alum may possibly be the result of entanglement of clay particles in insoluble alum floc.

The excess alum beyond the exchange capacity that is necessary for charge reversal is probably a function of the alkalinity present, as Langelier has shown that the optimum coagulant dosage increases with alkalinity. The many interacting exchange equilibriums prevent a really quantitative study of

a typical turbid water. The method used to determine the base-exchange capacity, involving the exchange of a monovalent cation, probably does not give an exact capacity for the exchange of trivalent aluminum or for its hydrolysis products, although the results for the three clays should be proportional.

tion, to reduce the coagulant dosage required, or to allow an increased treatment rate without overloading existing facilities. It is generally agreed that the polyelectrolytes adsorb on solid particles, forming bridges between them.

Polyelectrolytes may be cationic, nonionic, or anionic. Cationic poly-

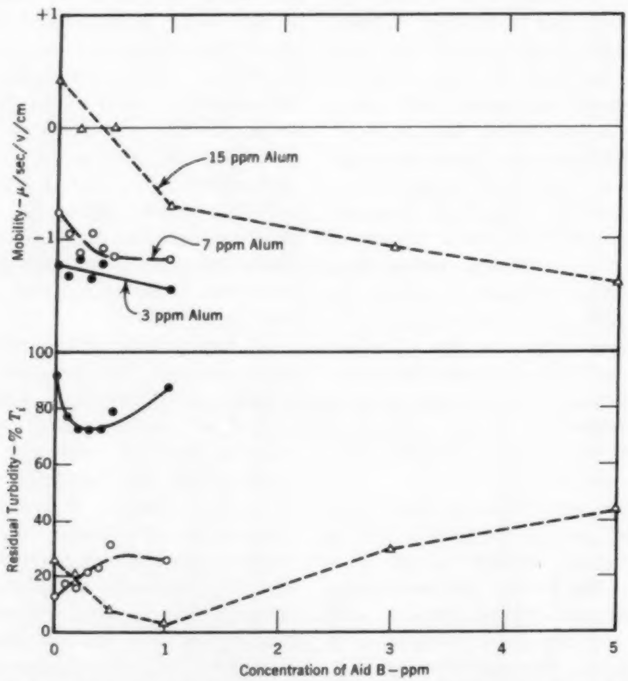

Fig. 6. Effects of Aid B on Mobility and Coagulation of Kaolinite

The aid was added 2 min after the alum.

Polyelectrolytes

Polyelectrolytes are polymers with high molecular weights possessing such characteristics of simple electrolytes as electrical charges or ionizable groups. They are used in water treatment either alone or in conjunction with metal coagulants to improve clarifica-

mers should adsorb on negative clay particles because of the electrostatic attraction; nonionic polymers could adsorb and flocculate by hydrogen bonding between the solid surfaces and the polar groups in the polymers. Electrostatic repulsion should play a part in the flocculating action of polyanions. Michaels [13] listed three pos-

sible mechanisms for coagulation of clay with polyanions: (1) replacement of anionic groups of the clay with anionic groups of the polymer; (2) hydrogen bonding between the solid and the polymer; and (3) the formation of electrostatic bridges between the clay and polymer by polyvalent cations. Working with slurry concentrations of clay, he concluded that adsorption of polyanions was probably by hydrogen bonding between un-ionized carboxyl or amide groups on the polymer chain and oxygen atoms on the solid surface. Controlled hydrolysis experiments showed that anionic polyelectrolytes should have enough charged sites to extend the polymer chains sufficiently to permit interparticle bridging without increasing the charge density enough to interfere with adsorption on the negative particles.[14] The pH would be expected to affect the ionization of the polymer and thus should affect the adsorption and coagulation. Even though a polymer is not adsorbed, it may affect the zeta potential just as any other electrolyte. Some mechanical aspects of coagulation with polyelectrolytes have been summarized by Black.[15]

Although polyanions are quite effective as sole coagulants in concentrated clay suspensions, they generally require a flocculating dose of metal coagulant when used in water treatment processes. Ruehrwein and Ward[16] thought that polymer bridges would form better where particles were already flocculated, otherwise the polyelectrolyte molecules might adsorb completely on individual particles without bridging. Cohen[17] used anionic, cationic, and nonionic coagulant aids with synthetic and natural waters. The anionic aid was found to be effective only as an aid to the metal coagulants. Its effectiveness was nearly independent of pH, alkalinity, hardness, and turbidity, but the optimum dosage of anionic acid increased linearly with the alum dosage. The cationic compound was both a coagulant alone and a coagulant aid. The nonionic aid was less effective than either the anionic or cationic aid. It is not presently known whether the different behavior of polyanions in dilute and concentrated clay suspensions is significant in terms of the mechanism of coagulation.

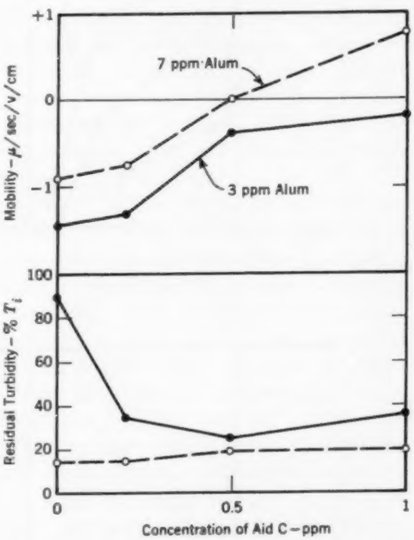

Fig. 7. Effects of Aid C on Mobility and Coagulation of Kaolinite

The cationic aid was added 2 min after the alum.

Polyelectrolyte Series

In the polyelectrolyte series, kaolinite working suspensions containing 50 ppm $NaHCO_3$ were coagulated with alum and selected polyelectrolytes by use of the same jar test procedure previously

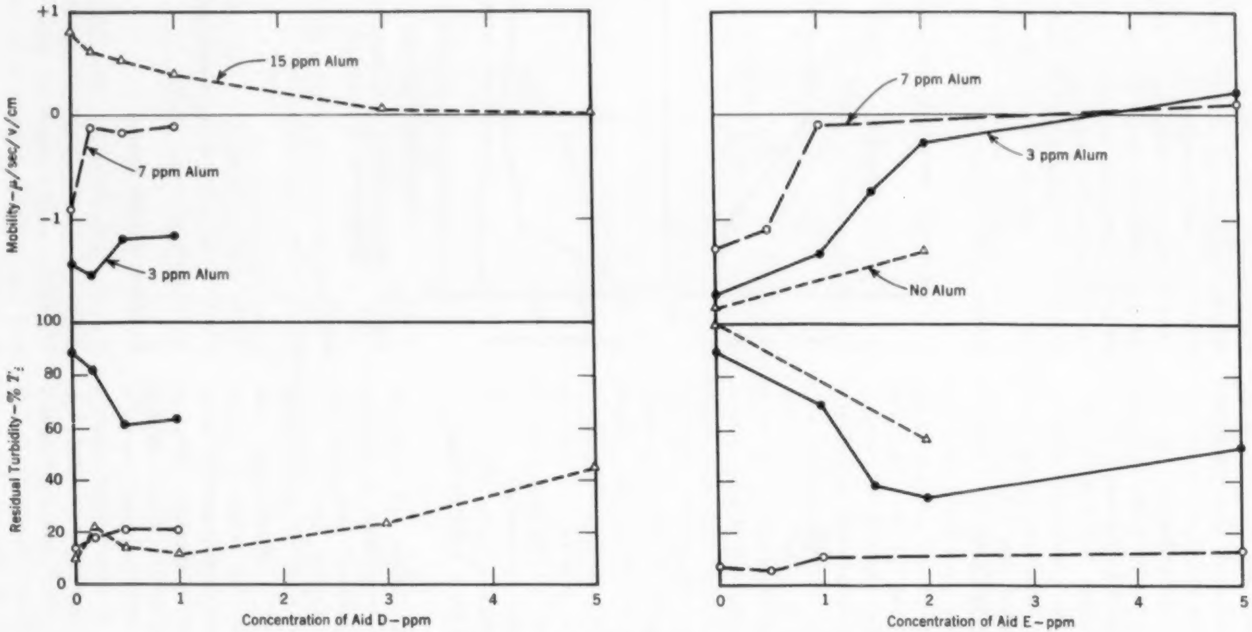

Fig. 8. Effects of Aids D and E on Mobility and Coagulation of Kaolinite

The curves on the left pertain to Aid D; on the right to Aid E. Both aids were added 2 min after the alum. Same charge reduction and coagulation were produced where 2 ppm of Aid E was used without alum.

described. Unless stated otherwise, the aid was added 2 min after the alum. Turbidity and pH were measured as before, but the pH was not controlled. Mobilities were run on the jar test flocs in this series. It will be noted that both mobilities and residual turbidities for given alum dosages and no coagulant aid will be quite different in some of the following figures. These differences represent aging effects in the clay suspensions, and, therefore, the effectiveness of one aid may not be directly compared to that of another.

Aid A. The effects of Aid A * are shown in Fig. 5. This aid, prepared by the "Baylis sol method," [18] was added to the suspension before and after the alum. The order of addition had little effect on the final particle mobility, all mobilities becoming more negative with increasing silica dosage because of the anionic character of the aid. The differences in turbidity reduction are therefore not reflected in particle mobilities for an alum dosage of 7 ppm. Although the particles coagulated with 7 ppm alum and no aid had lower negative mobilities than particles coagulated with 15 ppm alum and 3 or 5 ppm aid, the latter were flocculated much more completely.

Starch. Figure 5 also shows the effects of starch, prepared by adding potato starch to boiling water. Mobility values were irregular and appeared to be suppressed as the dosage of aid was increased. Clarification was slightly improved with low dosages of aid and inhibited with higher dosages as the cloudy starch contributed to the final turbidity.

Aid B. The effects of Aid B † are shown in Fig. 6. This material, described as an acrylamide-type synthetic polymer of high molecular weight,[19] is anionic and formed dense flocs that settled well where excess alum was added initially. The best coagulation was obtained at a negative mobility, rather than at a point of particle neutrality.

Aid C ‡ is described as an organic coagulant of high molecular weight.[20] It is cationic and caused the particle mobilities to become more positive, as shown in Fig. 7. In contrast to the anionic aids, this material greatly increased turbidity reduction where insufficient alum was used. Where enough alum was present for good coagulation, the aid had little effect on coagulation, but it caused a large change in mobility.

Aid D. The effects of Aid D § are shown in Fig. 8. This material is guar gum derived from the guar seed, and is described as a polysaccharide consisting of a complex carbohydrate polymer of galactose and mannose. It is said to alter the electrokinetic properties of colloidal suspensions by a hydrogen-bonding effect.[21] This aid slightly improved coagulation with the low alum dosage. Higher dosages of aid inhibited coagulation with 15 ppm alum, although the particle mobilities decreased.

Aid E. Aid E ‖ is described as a natural polymer derivative. This material is cationic and behaved very much like Aid C, as shown in Fig. 8. The aid initiated some coagulation when used without alum.

Aid F. Aid F,** which is carboxymethylcellulose, is anionic, as shown

* N Brand Silica, made by Philadelphia Quartz Co., Philadelphia, Pa.

† Separan NP10, made by Dow Chemical Co., Midland, Mich.

‡ Nalco 600, made by Nalco Chemical Co., Chicago, Ill.

§ Jaguar WPD, made by Stein, Hall & Co., New York, N.Y.

‖ Ceron CN, made by Hercules Powder Co., Wilmington, Del.

** CMC 12H, made by Hercules Powder Co., Wilmington, Del.

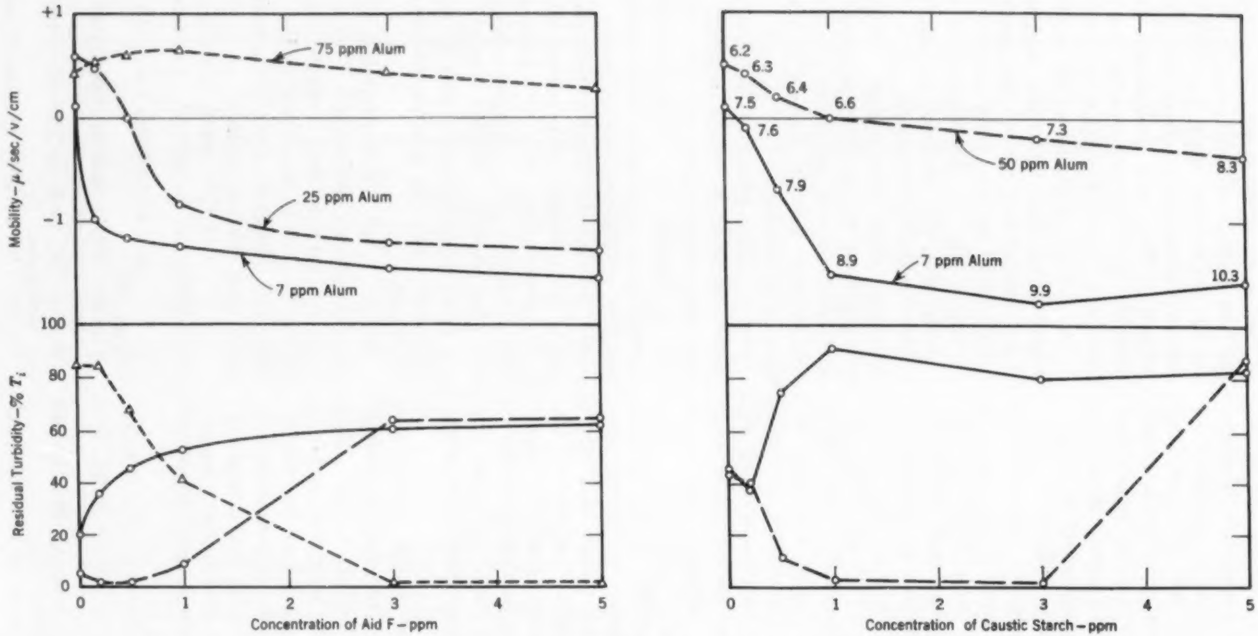

Fig. 9. Effects of Aid F and Caustic Hydrolized Starch on Mobility and Coagulation of Kaolinite

The curves on the left pertain to Aid F, which was added 2 min after the alum. A dosage of 3 ppm Aid F coagulated the suspension, which had previously been stabilized by 75 ppm alum. The curves on the right pertain to the starch, which was added after the alum. Numbers on the curves are pH values of the treated suspension. Changes in mobility and coagulation are primarily the result of pH changes brought about by the caustic content of the aid rather than by the starch.

in Fig. 9. Coagulation was inhibited with a small alum dosage, improved with a moderate alum dosage, and greatly improved where an excess of alum had placed the suspension in the poor flocculation zone between the primary and secondary coagulation zones described by Langelier.[3,4] Again, turbidity removals were not predictable from final particle mobilities.

Caustic starch. The last aid used was caustic hydrolyzed starch, prepared by suspending 1.75 g of potato starch in 500 ml of deionized water containing 2 per cent NaOH. Although coagulation was improved by some dosages of aid, as shown in Fig. 9, the changes in pH from the caustic content of the aid made it impossible to distinguish the effects of the starch alone.

The anionic aids in general appeared to work best where the particle charge had been neutralized with alum. The cationic aids were most efficient with low alum dosages.

Summary

The zeta potential of clay particles was found to be dependent on the pH and on the alum dosage. An amount of alum equivalent to several times the base-exchange capacity of the clay suspension was required to neutralize the particle charge. Clarification was best in the range pH 7.5–8.5 where the particles were negative, rather than at pH values where the particle charge had been neutralized. Fair coagulation was often obtained below pH 4.5 where the particles were nearly neutral. In many instances, residual turbidities changed sharply without any accompanying change in mobility values.

The eight coagulant aids used with alum all could be made to improve or inhibit coagulation by selection of dosages of alum and aid. As in the coagulation at different pH values, final particle charges could not be correlated with residual turbidities.

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Monthly Water Bond Interest Costs and Sales

A report of the Chief, Basic Data Branch, Div. of Water Supply & Pollution Control, US Public Health Service, Washington, D.C.

Month	1960 Net Interest Cost—*per cent*		Total Bond Sales—*$1,000,000*		
	General Obligation Bonds	Revenue Bonds	1960	1959	1958
Jan.	3.95	3.86	20.5	28.3	35.3
Feb.	4.00	4.48	39.5	62.1	56.7
Mar.	4.12	5.63	15.8	57.0	24.8
Apr.	3.86	4.34	36.7	44.4	40.0
May	3.77	4.28	48.6	105.5	22.7
Jun.	3.77	3.77	110.7	50.3	20.1
Jul.	3.96	3.92	32.4	17.3	39.0
Aug.	3.33	4.02	46.3	25.5	37.7
Sep.	3.53	3.74	15.3	16.6	14.3
Oct.	3.61	3.79	19.0	68.4	60.8
Nov.	3.25	3.80	16.4	36.3	42.5
Dec.	3.54	4.20	74.9	18.4	11.5
Total			476.1	530.1	405.4

History of AWWA's New Jersey Section

Samuel F. Newkirk Jr. and Percy S. Wilson

A paper presented on Oct. 20, 1960, at the New Jersey Section Meeting, Atlantic City, N.J., by Samuel F. Newkirk Jr., Engr. & Supt., Board of Water Comrs., Elizabeth, N.J., and Percy S. Wilson, Mfr.'s Repr., Glen Ridge, N.J.

THE New Jersey Section of AWWA was organized in 1935, but New Jersey members of AWWA played important parts in the sectional activities of the Association many years before then. The organization of the New Jersey Section cannot be considered properly without an examination of the events that preceded the formation of the section.

Early Sectional Activities

New York Section. The New York Section was the first to be formed. It originated in about 1912 from a kind of a luncheon club consisting of those members of the Association who were located in and around New York City. The organization of the club as a section soon followed, and the section's first meeting was held at the Manhattan Hotel in New York City on Jan. 20, 1914. The March 1914 JOURNAL [1] stated that the section "was formed by the members residing in the states of New York and New Jersey. . . ." At that first meeting, a committee was appointed to nominate officers. The committee included D. W. French, of the Hackensack (N.J.) Water Co., and John H. Cook, of the East Jersey Water Co. at Paterson. Among the officers nominated by the committee was Morris R. Sherrard, of the Newark Water Department. At the second meeting of the section, on Mar. 10, 1914, the principal speaker was Herman Rosentreter, of the Newark Water Department, who gave a paper on the Newark water utility. Subsequent reports of the activities of the section make frequent mention of its New Jersey members, including Allan W. Cuddeback, of Passaic Water Co.; F. C. Kimball, of Summit; A. A. Reimer, of East Orange Water Department; George R. Spaulding, of Hackensack Water Co.; Carol P. Bassett, of Commonwealth Water Co.; Frank Green, of Little Falls Filter Plant; and others. The formation of the New York Section, pioneered by New York and New Jersey water supply men, appears to have triggered a wide general movement for the formation of sections of the Association, which took place within the next few years, during which time many new sections were formed.

Four States Section. One of the new sections formed during this period was the Four States Section, organized at a meeting at the Bellevue-Stratford Hotel in Philadelphia, on Jan. 18, 1916. It was stated in the December 1915 JOURNAL [2] that this section was formed by "members of the Association residing in Eastern Pennsylvania, New Jersey south of and including Trenton, Delaware, and Maryland. . . ." Among the officers first elected was Lincoln Van Gilder of Atlantic

City, N.J., who was the first vice-president. The first secretary-treasurer was C. R. Wood, of the Millville (N.J.) Water Co.

Thus, it is evident that New Jersey has been included in sectional activities of the Association as long as there have been sections, and New Jersey water supply men have been among the leaders in the sectional organization.

New Jersey Water Works Association

It was probably quite natural that the northern part of New Jersey should have been organized around the New York City metropolitan area, and that the southern part of the state should have been organized around the Philadelphia metropolitan area. This division of the state, however, was not entirely satisfactory. Possibly the development of automobile transportation, making it easier to get around the state, was a factor; but, at any rate, the need for a single organization to include all of New Jersey became evident, and it showed itself most definitely in the formation, in 1931, of the New Jersey Water Works Association. This group was formed at a meeting in the Elks Club, now the Essex House, at Newark, on Jan. 29, 1931. William C. Flanders was its secretary. The immediate reason for this organization was for the promotion of a tenure-of-office law for water superintendents.

Proposals for New Jersey Section

At a meeting of the New Jersey Water Works Association on Sep. 4, 1931, a resolution was passed petitioning AWWA to allow the New Jersey association to become a section of AWWA. The petition was not granted. From available records, it appears that this petition was based on the simple fact that it was subscribed to by at least twenty members of AWWA; under the AWWA Constitution at that time, this subscription was all that was required to form a section in new territory. Probably not enough effort was put forth at that time to secure the support of all the members in the state, some of whom were probably still loyal to the New York Section and the Four States Section, to which they belonged. The New Jersey Water Works Association therefore continued divided and was, nevertheless, active.

In 1934, the question of a New Jersey Section of AWWA again arose. One of the authors of this article, P. S. Wilson, had recently returned to New Jersey, after spending several years in New York State, with fresh recollections of the advantages of being affiliated with the national organization of AWWA. When it was learned that S. F. Newkirk, the other author, had been considering the subject, the two men met on Nov. 27, 1934, and decided to proceed at once to see what support could be obtained for the formation of a New Jersey Section.

Other conferences, in rapid succession, were held with the officers of the New York Section, Four States Section, AWWA, and with others. Two petitions were drawn up—one for members requesting the formation of a New Jersey Section, the other for nonmembers indicating their expectation to become members if a New Jersey Section were formed. Much support was found for the proposal, but it was far from unanimous.

On Jan. 9, 1935, Wilson addressed a meeting of the New Jersey Water Works Association in Trenton, proposing the formation of a section. At another meeting, again in Trenton, on Mar. 21, the New Jersey Water Works

Association decided against the movement. The officers of the two existing sections did not favor the proposal, but the discussion persisted. The most telling argument in favor of the proposal was the fact that the New York Section had never held a meeting in New Jersey, thus showing that it was not giving due consideration to this part of its territory. The Four States Section had held some meetings in New Jersey, but it would have been illogical to form a New Jersey Section without including the whole state.

Formation of Section

In spite of the opposition, the list of signatures on the petitions grew. Members of AWWA in New Jersey became convinced that the organization of New Jersey water supply men would be most effectively accomplished with the support and stability derived from the national organization of AWWA. Finally, at the AWWA Conference at Cincinnati, on May 7, 1935, Wilson formally presented the petitions to the AWWA Board of Directors. The petitions at that time carried the signatures of 53 active members of AWWA residing in New Jersey, which was more than half of them, and the signatures of 19 nonmembers. One of the Directors said, "It would be hardly possible to turn down the petition." Seth Van Loan, Director from the Four States Section, who had previously opposed the creation of a New Jersey Section, said that in view of the new information and the growth in sentiment in favor of a section among the members living in New Jersey, he now wished to withdraw any opposition to its formation on the part of the Four States Section. The formation of a New Jersey Section was approved by a formal resolution of the Directors at that time.

Organization of Section

The first big hurdle had been passed, but a big job still remained. An informal, self-appointed "Organization Committee" was immediately set up to proceed with the work of getting the section organized. This committee consisted of eight men from New Jersey: J. Arthur Carr, of Ridgewood; William R. Conard, of Burlington; Charles H. Eastwood, of Belleville; Andrew F. Eschenfelder, of Glen Ridge; Samuel F. Newkirk Jr., of Elizabeth (acting chairman); Walter Spencer, of Merchantville; George F. Wieghardt, of Weehawken; and Percy S. Wilson, of Glen Ridge (acting secretary).

The name of William J. Orchard is not included in the recorded list of those on the Organization Committee. It would be remiss not to mention here that he was one of the most active supporters of the work of the committee. His help and encouragement were important factors in the success of the work.

The committee met frequently during the summer of 1935. It was desired not only to get the section off to a good, strong start, but also, particularly, to insure that existing differences of opinion regarding a section should be dissipated and that unanimous support should now be gained for the new section. Much thought and effort were given to accomplishing this. Finally, on Oct. 24, 1935, a mailing went out to 420 water supply men in New Jersey, requesting their attendance at an organization meeting. This meeting was held on Oct. 30, 1935, at 2:00 PM, in the auditorium of the Physics Building of Rutgers University at New Brunswick. A total of 86 persons attended. Permanent section officers were elected, and bylaws, which had been drafted by the Organi-

zation Committee, were adopted. Following this, the group was addressed by Thurlow E. Nelson on the subject of "Some Friends and Some Enemies in Our Drinking Water." The meeting adjourned to a supper served to 53 persons in the cafeteria, then located in Winants Hall on the university campus.

First Officers

The section officers elected at the organization meeting were: Samuel F. Newkirk Jr., chairman; Clinton D. Moon, vice-chairman; William J. Orchard, director on the AWWA Board; Percy S. Wilson, secretary-treasurer; and J. Arthur Carr, William R. Conard; and George F. Wieghardt, trustees.

One of the trustees elected was to fill the post of a past chairman during the first year. It should also be especially noted that Wieghardt was the former trustee of the New York Section; his office in that section had been abolished when the New Jersey Section was formed. Likewise, Conard was the former trustee of the Four States Section; Carr was an officer of the New Jersey Water Works Association.

Subsequent Meetings

The section thus got off to an auspicious start. All the meetings subsequently held will not be listed here, but to show that there was no lag, it should be mentioned that the second meeting was held at Trenton, on Jan. 29, 1936, at which time these papers were presented: "The Relation of Geology to Ground Water Supply in New Jersey," by Meredith E. Johnson; and "Quantitative Investigation of Some New Jersey Ground Water Problems," by Henry C. Barksdale.

A third meeting was held during the summer, and the fourth meeting was the first of the section's now long established fall meetings at Atlantic City. The front cover of the program of the fourth meeting established the fact that it was jointly sponsored by the New Jersey Water Works Association, the South Jersey Association of Water Superintendents, and the New Jersey Section of AWWA. No one was

TABLE 1

New Jersey Section Chairmen

Chairman	Year Elected	Chairman	Year Elected
Samuel F. Newkirk Jr.	1935	P. S. Wilson	1948
Samuel F. Newkirk Jr.	1936	Richard E. Bonyun	1949
William R. Conard	1937	Alonzo Shinn	1950
J. Arthur Carr	1938	E. Arthur Bell	1951
Edward Hyland	1939	Charles J. Alfke	1952
Charles H. Capen	1940	Walter Spencer	1953
William F. Ayars	1941	Charles G. Bourgin	1954
William G. Banks	1942	Maurice Brunstein	1955
Andrew F. Eschenfelder	1943	Harold M. Ohland	1956
George D. Norcom	1944	Martin E. Flentje	1957
William E. Collings	1945	John J. Reager	1958
Roswell Roper	1946	Lewis W. Klockner	1959
Edward D. Sheehan	1947	Perter E. Pallo	1960

slighted, and everyone heartily joined in support of this meeting. All past differences were forgotten in unanimous support for the new section. It was at about this time that the New Jersey Water Works Association's officers took action to formally merge that group into the New Jersey Section.

Thus, it was right from the start that the section's custom of holding three meetings a year was established. The second fall meeting was also held at Atlantic City. But the third fall meeting, in 1938, was held at Asbury Park. Since then all of the fall meetings have been held at Atlantic City. The section is considered fortunate in having such a meeting place as Atlantic City, which is attractive to the ladies as well as to the men, thus making possible a pleasant social atmosphere for meetings.

Secretary-Treasurers

The names of all of those who have held the office of section chairman are given in Table 1. It is appropriate, too, to name here those who have held the office of secretary-treasurer, the workhorse of the section: P. S. Wilson, 1935–37; Harry N. Lendall, 1937–39; C. B. Tygert, 1939–56; and A. F. Pleibel, 1956 to date.

It is the opinion of the authors that the secretary-treasurer of an AWWA section is the most important officer of the section. He should be, and usually is, reelected from year to year, and he therefore has the opportunity to become better acquainted with his duties than do any of the other officers. He provides continuity to section management and policies, and the other officers look to him for guidance. He is therefore able to make effective suggestions and can take the initiative in many actions. He can be a strong influence in guiding section activities, and it depends on him, to a large extent, whether the section is active and aggressive in taking part in state activities that concern water supply, or whether the section merely coasts along and performs only those functions necessary for its existence.

Resultant Trends

Previously in this article, it was noted that the formation of the New York Section by New York and New Jersey water utility men in 1914 appeared to have set an example for the formation of a large number of other sections of the Association, which followed closely upon it. It is extremely interesting to note that the formation of the New Jersey Section in 1935, and the attendant rearrangement of section boundaries, likewise appeared to set an example for a considerable number of similar section changes that followed in the next few years. Many individual state sections were formed out of larger sections. And more recently, a former New Jersey water utility man, E. Arthur Bell, has been one of the leaders in the formation of a separate Connecticut Section. New Jersey water supply men have left their mark on AWWA. They are referred to with pride, and with confidence that they will continue to be among the leaders in water supply progress.

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AWWA M8
Distribution
Manual

A Training Course in

Water Distribution

The first two chapters of this manual appear in this issue; succeeding chapters will be published in subsequent issues, after which the entire manual will be made available as a separate reprint under one cover (price and publication date to be announced).

Foreword

This manual on water distribution is the second in a series of four training courses for water utility personnel developed under the supervision of AWWA Committee 4260 M—Education. The first manual of the series, published in 1959, was devoted to the subject of water utility management; the remaining two manuals currently being developed relate to water treatment and to sources of supply.

This manual was prepared as a practical guide for operating personnel and should find application as a text in in-service training or for independent study.

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AWWA and the Committee on Education gratefully acknowledge the contribution of each of these men, whose only compensation will be the knowledge that their efforts have contributed to the advancement of the industry.

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CHAPTER 1

Distribution System Capacity

AFTER collection and processing of a water supply, the distribution system must deliver it to the ultimate users. The importance of the distribution system is obvious when it is realized that more than half of the total investment in water supply facilities is allocated to the distribution of finished water.

To be adequate, a distribution system must be capable of furnishing an ample supply of water of satisfactory sanitary and aesthetic quality whenever and wherever it is required in the service area. The system must maintain adequate pressures for normal residential, commercial, and industrial uses and for providing the supply necessary for fire protection. It is usually necessary to raise the water to a sufficient elevation to provide the pressures necessary to distribute it through the area pipelines to the service mains and through the individual customer services and meters. In most systems, distribution storage is necessary to equalize and reduce the peak loads placed on the production and transmission elements of the system. Booster pumping is often required to serve more elevated areas or remote customers. The distribution system includes the pumps, pipelines, control valves, hydrants, distribution storage, service connections, mains, and meters.

Any water utility, if it is to do an adequate job, must have adequate distribution facilities. Facilities alone are not enough, however; the person or persons responsible for distribution must be familiar with the means and methods properly to design, construct, operate, and maintain them.

Water Uses and Losses

The water processed in the production works does not all reach the ultimate users. Some of it is used up in processing, as, for example, in flushing basins, washing filters, and producing steam for pumping. Even in a fully metered system—that is, one in which the water going to each individual customer is constantly measured—there are uses and losses that cannot be fully accounted for, such as water discharged from hydrants for flushing streets and sewers, public water fountains, leakage and evaporation from reservoirs, and, in particular, water used for fire fighting. A portion is lost in leakage from joints in pipelines, from broken pipe, faulty

TABLE 1.1

Variations in Per Capita Demand for Various Periods From Standard Texts

Year	Yearly Average gpcd	Ratio of Period Demand to Yearly Average			
		Max. Month	Max. Week	Max. Day	Max. Hour
1900	60–85	1.15–1.30		1.50–2.00	
1927	50–400	1.25	1.35	1.50	
1940	110			1.50	2.10–2.25
1947	100–120	1.25	1.50	1.75	2.62–3.06
1948	110			1.50–2.00	2.00–3.00
1949	110	1.40		1.50–1.80	2.50–3.50
1953	135	1.28	1.48	1.80	2.70–3.25

valve and hydrant packing, and the like. Even customer meters cannot accurately record all water passing through them, particularly at very low flow rates; this, in the aggregate, can amount to an appreciable underregistration of system uses.

The difference between the net plant output and the sum of metered or estimated flow through customer services, is generally referred to as "unaccounted-for water." The losses and uses in such unaccounted-for water must be recognized in estimates of actual consumption.

The ultimate users of the water produced by a public water supply system are commonly classified as: (1) residential or domestic; (2) commercial; (3) industrial; (4) municipal or public; (5) wholesale, such as other water utilities; and (6) fire protection. Only a small percentage of the water served is actually used for fire protection, however.

The delivery of water to the system is commonly expressed in millions of gallons per day (mgd) or gallons per capita per day (gpcd). The latter is obtained by dividing the amount of water delivered daily to the system by the population served. It should be noted that this definition

TABLE 1.2

Ratio of Average Consumption Rates During Various Maximum-Demand Periods to Average Annual Production Rate

Maximum-Demand Period	Consumption Rate per cent	Maximum-Demand Period	Consumption Rate per cent
1 year	100	5 day	132
9 month	102	1 day	142
6 month	105	18 hr	150
3 month	109	10 hr	170
1 month	113	5 hr	188
2 week	120	2 hr	195
1 week	125	1 hr	200

does not include the amount of water used in the production processes, although the latter must be included in determining total supply requirements.

Estimation of Demand

Demand Variations

Rarely does a system produce or serve water at an average rate. The rate varies considerably over the year and during the day and differs in various sections of the country and in different types of communities. Data on average consumption and variations in consumption given in various textbooks are an indication of the growth in demand over the years (Table 1.1). Another fairly general schedule of period consumption rates, perhaps more applicable to the northeast quadrant of the United States, is shown in Table 1.2.

These figures are only general estimates based on past experience. They should be used with caution in forecasting future requirements, for many variables influence their applicability to any one system. Some of these variables are local climatic conditions, the character of community served, the extent of air-conditioning and lawn-sprinkling use, the relative amount of commercial and industrial development, and the percentage of customers metered.

For these reasons the past records of water use in a particular city or community are more valuable, in forecasting future requirements, than comparisons with other cities or reference to general averages. Each water utility should set up and maintain records of how much water goes to the various classes of consumers, so that in estimation of future demands the trend of development of the community and its effects upon water use can be better determined.

Population Estimates

Forecasts of future water demands are commonly based on population estimates and on per capita consumption. Estimates of future population to be served are difficult to make, because so much depends on human judgment. There are a number of methods for projecting population estimates into the future. Four of these are in common use and are described below, with some of their limitations. Although all of the methods have applicability to the problem of estimating the future water needs, the rate of population change in most American cities undergoes such large variations that accurate predictions are very difficult to make.

Arithmetic method. In the arithmetic method of estimating population, it is assumed that the population increases by a set amount for each increment of time. The amount to add for each increment is determined by or based upon the increase during the last census period. Obviously,

this method is applicable only for cities with a stable population growth and in areas which cannot expand appreciably in area.

Uniform percentage of growth. Some cities tend to grow at a rate corresponding to a uniform percentage of the population of the preceding period. This rate of growth, when plotted, gives a compound-interest type of curve—that is, concave upward. In nearly all cases, this method produces overestimates of future growth.

TABLE 1.3

Average Metered Customer Use in Privately Owned Water Systems

Year	Residential	Commercial	Industrial	Other	Total System Average
Metered Sales per Customer—*gpd*					
1948	141	646	31,200	8,080	445
1949	143	654	30,800	9,160	438
1950	139	654	32,200	9,150	432
1951	134	641	36,600	9,430	446
1952	143	675	35,100	9,900	446
1953	147	681	37,500	10,420	455
1954	152	671	35,100	10,720	441
1955	151	670	38,200	10,390	443
1956	151	659	38,900	10,180	431
1957	153	659	36,200	10,200	420
1958	145	633	33,800	11,620	400
1959	154	675	38,800	12,180	428
Metered Percentage of Total Water Served					
1948	19.6	15.4	30.4	8.7	74.1
1949	20.8	16.2	30.3	8.4	75.7
1950	20.8	16.2	30.9	8.1	76.0
1951	20.1	15.5	34.9	8.3	78.8
1952	21.5	15.8	32.5	8.6	78.4
1953	21.8	15.6	32.5	8.6	78.5
1954	23.4	15.5	30.6	9.2	78.7
1955	24.3	15.7	33.1	9.1	82.2
1956	25.1	15.6	33.2	9.2	83.1
1957	25.9	15.2	31.0	9.4	81.5
1958	25.9	15.1	29.5	9.8	80.3
1959	26.1	15.0	30.8	9.6	81.5

Decreased rate of growth. As cities grow older and larger, the percentage increase in population per increment of time tends to decrease. Thus there is a "deceleration" in population growth, although the total population continues to grow. Taking this deceleration into account more accurately represents the actual experience of cities which are not affected by abnormal conditions.

Comparative method. In the comparative method, a curve of the past population increase of a given community is drawn and extrapolated into the future by comparison with similar curves for various larger cities from the period when their population equaled the current population of the given city. An objection to this method is that it may be based upon a comparison of cities with quite different characteristics and during very different periods of time.

Customer Requirements

The difficult problem of planning for future water requirements on the basis of population growth is further complicated by the fact that accurate population figures are secured by enumeration only every 10 years, and then only in political subdivisions. Major changes can occur in the intermediate periods, and most systems usually serve areas not coextensive with political subdivisions. As a consequence, many planners prefer to base future estimates upon past demands in the various consumer classifications rather than on total population estimates. Most water systems have accurate, continuous, and up-to-date records of the number of customers served in the various service categories. Proper records of the amount of water served these customers over the years, modified by proper analyses of changing conditions, form a more accurate and logical basis upon which to determine future demands than do estimates of population and per capita uses.

Table 1.3 gives the metered sales, in gallons per day, to various customer classes and the percentage distribution of sales in the several use categories from 1948 through 1959 in 65 privately owned water utilities. The data are representative of various types of communities located in the northeast quadrant of the United States.* The number of services involved grew, in the 11-year period, from 695,000 to 775,000, and represented total attached populations of 3,150,000 and 3,520,000, respectively. It should be noted that the total metered sales per customer actually declined in the period. There was a substantial decrease in the percentage of unaccounted-for water. Although there was an increase in the percentage of sales and each class of customer showed an increase in the actual amount of water bought, the total sales per metered customer decreased.

With such statistics of past operations and an intelligent estimate of future developments, it is possible to forecast requirements quite accurately for a reasonable period in the future. This method has much to recommend it over the commonly used population–per capita use method.

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* For data on per capita use in various sections of the United States, reference should be made to "A Survey of Water Works Data for 1955," *Journal AWWA*, 49:553 (May 1957).

TABLE 1.4

Industrial Water Requirements

Product or Use	Unit	Water Required *gal*
Chemicals		
Alcohol, industrial, (100 proof)	gal	120
Alumina (Bayer process)	ton	6,300
Ammonium sulfate	ton	200,000
Butadiene	ton	20,000–660,000*
Calcium carbide	ton	30,000
Carbon dioxide (from flue gas)	ton	20,000
Cottonseed oil	gal	20
Explosives	ton	200,000
Hydrogen	ton	660,000
Oxygen liquid	cu ft	2
Soap (laundry)	ton	500
Soda ash	ton	18,000
Sodium chlorate	ton	60,000
Sulfuric acid	ton	650–4,875*
Foods and Food Processing		
Bread	ton	500–1,000†
Canning (#2 cans)	case	8–250†
Corn (wet-milling)	bu	140–240†
Corn syrup	bu	30–40†
Dairy products:		
Bottling	ton	9,000
Butter	ton	5,000
Cheese	ton	4,000
Gelatin (edible)	ton	13,200–20,000†
Meat:		
Packing	ton‡	4,130
Packing house operation	hog unit	550
Sugar:		
Beet sugar	ton	2,160
Cane sugar	ton	1,000
Paper and Pulp		
Ground wood pulp (dry)	ton	4,000–50,000*
Kraft pulp (dry)	ton	93,000
Soda pulp (dry)	ton	85,000
Sulfate pulp (dry)	ton	70,000
Sulfite pulp (dry)	ton	70,000–133,000*
Paper	ton	39,000
Paperboard	ton	15,000–90,000*
Strawboard	ton	26,000
Petroleum		
Gasoline (natural)	gal	20
Oil refining	bbl	770
Refined products	bbl	150–15,000*
Synthetic Fuel		
Coal hydrogenates	bbl	7,296
Coal derivatives	bbl	11,150
Natural-gas derivatives	bbl	3,736
Shale derivatives	bbl	873
Textiles		
Cotton:		
Bleaching	ton	60,000–80,000
Dyeing	ton	8,000–16,000
Rayon:		
Cuprammonium yarn	ton	90,000–160,000†
Viscose yarn	ton	200,000
Weave, dye & finish	yd	15
Woolens	ton	140,000
Miscellaneous		
Cement, portland	ton	750
Coal & coke:		
Byproduct coke	ton	1,500–3,600†
Washing	ton	200
Electric power, steam-generated	kwhr	80–170*
Hospitals	bed-day	135–150
Iron ore (brown)	ton	1,000
Laundries:		
Commercial	ton work	8,600–11,400†
Institutional	ton work	6,000
Leather tanning	bbl raw hide	8
Rock wool	ton	5,000
Steel (rolled)	ton	15,000–110,000*
Sulfur mining	ton	3,000
Synthetic rubber:		
Buna S	ton	631,450
GR-S	ton	28,000–670,000*

* Range from no reuse to maximum recycling.
† Range covers various products or processes involved.
‡ Live animals.

Industrial expansion and development and the advent of new industries, processes, and uses can have an important effect and produce real problems in a distribution system. Table 1.4 gives an indication of the quantity of water needed for various industrial uses.

It is impossible to predict the future accurately, but it is equally impossible to guide any design for the future without adequate operating records of the past and present.

Fire Flows

In addition to the normal residential, commercial, industrial, and other demands placed on a water system, fire demands must be taken into account in the design of various system elements. The generally accepted standard for determinations of the total quantity of water that should be available for fighting fires—as well as of the relative efficiency, adequacy, and reliability of the water system—along with other elements applicable to municipal fire defenses is the grading schedule promulgated by the National Board of Fire Underwriters (NBFU).*

Periodically NBFU studies the fire defenses and physical conditions of municipalities and assigns deficiency points to the various elements involved.

TABLE 1.5

Relative Weights of Various Factors in Municipal Fire Protection

Factor	Deficiency Points
Water supply	1,700
Fire department	1,500
Structural conditions	700
Fire alarm	550
Fire prevention	300
Building department	200
Police	50
Total	5,000

Municipalities are divided into ten classes, one for each increment of 500 deficiency points for a total of 5,000 points in the lowest class. The relative importance of each feature, in terms of the maximum deficiency points allocated to it, is given in Table 1.5.

Additional deficiency points may be assigned because of climatic conditions or the excessive divergence between classes in water supply and fire department which makes it impossible to utilize the better class to its full value.

The required fire flow in high-value districts for average municipalities is given in Table 1.6. The required flow is based upon the formula

$$G = 1{,}020\sqrt{P}(1 - 0.01\sqrt{P}),$$

in which G is the required fire flow, in gallons per minute, and P is the population in thousands. One third of the required fire flow determined by the formula is considered to be the probable loss of water from broken connections, abandoned flowing hydrants, and other causes incident to a large fire in a high-value district. Also shown in Table 1.6 are the number

* *Standard Schedule for Grading Cities and Towns of the United States With Reference to Their Fire Defenses and Physical Conditions.* National Board of Fire Underwriters, New York (1956). [Available to AWWA members upon request from NBFU, 85 John St., New York 38, N.Y.]

of standard hose streams and average area served per hydrant in the high-value district.

The standards were not arbitrarily set by NBFU, but were based on fundamental engineering principles and subjected to critical review by

TABLE 1.6

Required Fire Flow and Standard Hydrant Spacing in High-Value Districts

Population *1,000's*	Flow Required *gpm*	Duration *hr*	Avg Area per Hydrant *1,000 sq ft*	Population *1,000's*	Flow Required *gpm*	Duration *hr*	Avg Area per Hydrant *1,000 sq ft*
1	1,000	4	120	22	4,500	10	
1.5	1,250	5		27	5,000	10	85
2	1,500	6		33	5,500	10	
3	1,750	7		40	6,000	10	80
4	2,000	8	110	55	7,000	10	70
5	2,250	9		75	8,000	10	60
8	2,500	10		95	9,000	10	55
10	3,000	10	100	120	10,000	10	48
13	3,500	10		150	11,000	10	43
17	4,000	10	90	200*	12,000	10	40

* Over 200,000 population, 12,000 gpm, with 2,000–8,000 gpm additional for a second fire, for a 10-hr duration.

water utility managers, fire chiefs, fire alarm superintendents, and others. The 32 main items considered under water supply are listed below.

1. Appointment of employees
2. Qualifications of executive
3. Plans and records
4. Emergency provisions
5. Receipt and response to fire alarms
6. Normal adequacy of entire system
7. Reliability of source of supply
8. Reliability of pumping capacity
9. Reliability of electric-power supply
10. Reliability of power supply other than electric
11. Condition, arrangement, and reliability of plant equipment
12. Construction of pumping station
13. Fire protection of pumping station
14. Hazards in pumping station
15. Exposure hazard to pumping station
16. Reliability of supply mains as affecting adequacy
17. Reliability of installation of supply mains
18. Arterial system
19. Reliability of installation of mains
20. Local distribution in high-value district considered
21. Small mains in distribution system
22. Dead ends
23. Gridiron
24. Quality and condition of pipe
25. Supply in areas other than high-value district considered
26. Spacing of valves
27. Inspection and condition of gate valves
28. Hydrant distribution in high-value district considered
29. Hydrant distribution in residential and other districts
30. Inspection and condition of hydrants
31. Size and installation of hydrants
32. Valves on hydrant connections

NBFU makes the rating for cities of 25,000 or more. In smaller cities it is done by the insurance rating organization having jurisdiction. The normal procedure in cities graded by NBFU is for a party of three engineers to visit the city, stay a period of from 2 weeks to 2 months, and collect the data necessary to prepare a report covering all features of fire prevention and protection.

A list of the state fire insurance inspection and rating bureaus can be secured from the New York, Chicago, or San Francisco offices of NBFU.

Reference should be made to the NBFU schedule for further details relating to required fire flows in other than high-value districts as well as for requirements and deficiencies which pertain to other elements of the distribution system.

Pressure Requirements

An adequate distribution system must be able not only to furnish the necessary flow of water to various points in the system but also to maintain the pressures necessary to furnish each customer with sufficient pressure at his connection to satisfy his normal requirements.

The principal requirement considered by the NBFU in grading a water system is ability to deliver water in sufficient quantities to permit pumpers of the fire department to obtain an adequate supply from hydrants. The fire flow standards set by NBFU require a minimum residual water pressure of 20 psi * during flow. Residual pressure, in this instance, is defined as the pressure in the main system near or amid the points at which hydrant flows are taking place.

The principal reason for a minimum residual-pressure requirement of 20 psi is that this pressure is sufficient to overcome the friction loss in the hydrant branch, hydrant, and suction hose and furnish the supply to the fire pumper under pressure. The 20-psi residual pressure has been more or less accepted by the water industry as the minimum acceptable pressure for furnishing domestic service to a residential customer. If 20 psi (46 ft of head) is available in the street and the customer has a two-story house located somewhat above street level, after allowance for friction losses in the customer's service branch, meter, and house piping there remains about enough pressure to provide a minimum flow at the second-story level. A pressure of 30 psi is a more desirable minimum for normal residential requirements.

Normal pressures in a distribution system under average conditions of flow should range between 50 and 80 psi. The NBFU gives some credit for residual pressures in excess of 60 psi, and, in some cases, 75 psi, main-

* Where hydrant distribution is standard (see Table 1.6) and hydrants are satisfactory, a residual pressure of 10 psi is specified.

tained under fire demand, particularly in high-value districts, as such pressures permit the fire department to use direct streams from the hydrants effectively without pumpers.

The topography of a service area has much to do with the maintenance of good pressures throughout the system. When the area is very hilly and has a considerable range of elevation, it becomes nearly impossible to effect a standard pressure which is neither too high in the low areas nor too low in the high areas. Pressures in excess of 100 psi should preferably be avoided, but sometimes they cannot be. When such high pressures are necessary, it is wise to have the individual customers provide pressure-reducing valves to limit the pressures to 100 psi or less.

Although excess pressures promote pipeline failures and excess leakage, the losses resulting from increased leakage and the cost of repairing mains (for the most part) broken by pressure increases are usually more than offset by the increased revenues resulting from better registration of meters and increased usage. This is true, of course, only if the system is substantially metered.

Unaccounted-for Water

Conservation of water is a fundamental and proper concern of water system operation, not only to prevent depletion and ill use of an important natural resource, but to secure direct money savings in operation and long-range savings in deferred capital costs for plant expansion. Good modern water utility practice dictates that all customer services be metered whenever possible. Plant output as well as plant uses should likewise be metered to secure proper records. The difference between the total net plant output delivered to the distribution system and the total measured quantity of water passing through customers' services for the same specified time is termed the "unaccounted-for" or the "non-revenue-producing" water.

Use of Estimates

In order to reduce unaccounted-for water as much as possible, many operators attempt to estimate the amount of unmetered uses, such as street flushing and fire-fighting or service to publicly owned buildings, hospitals, and charitable institutions. Such attempts sometimes go as far as to include allowances for system leakage and underregistration of customer meters and thereby account for almost all the water produced.

In systems which are completely metered, or substantially so, a proper determination of unaccounted-for water should contain no estimates, for, in the final analysis, the judgment of the estimator is biased by his desire to explain away excess losses, waste, or unmetered uses. In systems where

only partial metering is in effect, accurate estimates of unaccounted-for water are virtually unobtainable. If unmetered customers form a relatively small percentage of the total, an estimate of water used by such customers based upon the average use of similar metered customers may be proper to secure a reasonable estimate, but the basis for such estimates should be recorded.

The amount of water used for flushing streets and fighting fires is relatively small. It has been estimated by some operators to be 1–3 per cent. The amount of water lost in the pipe system through unavoidable leakage—that is, leakage in mains and services which would cost more to locate and stop than the lost water is worth—has been variously estimated at 1,000–3,000 gpd per mile of pipe, depending on such factors as the age and condition of the pipe system, prevailing system pressures, and ground conditions. Underregistration of meters in a system may vary from as low as 2 per cent to as high as 15 per cent, depending upon the size of meter and efficiency of the meter maintenance program. Unauthorized uses of water, such as through an unmetered fire line or, on occasion, by deliberately bypassing meters, sometimes prove to be an important factor.

Desirable Results

The proper amount of unaccounted-for water in any given system is a function of that system alone. It might range, in a substantially fully metered system, from as much as 35 per cent to as little as 5 per cent. The former percentage may apply if pressures are very high and variable, leakage is difficult to detect and remedy, the pipe system is extensive and old, or practically all customers use water only in small amounts (a principal cause of underregistration of meters). The smaller percentage may be a result of low pressures, the existence of only a few customers who each take a considerable percentage of the total water, and a small mileage of mains. A fair average of unaccounted-for water might be 10–20 per cent for fully metered systems with good meter maintenance programs and average conditions of service.

Expansion of Service Areas

Expansion of service areas presents one of the most critical problems in the provision of adequate and reliable water service. In most cities, great increases in population are not taking place within the political boundaries; they are more often taking place through rather haphazard annexation of outlying areas. County- or area-wide planning is becoming increasingly necessary to determine adequately the extent of the future growth of a water system. The extent of such expansion, both in the immediate and more remote future, must be recognized in planning the distribution system.

Need for Area Planning

Every growing community is faced with problems relating to extension of water service to rapidly growing areas contiguous to or even detached from the developed distribution system. In cities these areas are usually outside the municipal limits, but they nevertheless become metropolitan-area problems and are sometimes not covered by city planning. It behooves the planner, however, to consider such areas as part of the municipal system, even though they are not now under the city jurisdiction, for, sooner or later, they will be annexed or, at least, form a part of the built-up metropolitan area, and responsibility for service will devolve upon the city. This applies as well to privately owned water utilities, which, however, are not as conscious of municipal limits in their planning as are municipal authorities.

Quite often the outlying adjacent areas have not been the subject of engineering studies, and data such as maps and population statistics are not available. Some integrated plan must be set up on an area basis to correlate their development with that of the municipality. This may sometimes be difficult, as these developments are usually promoted outside the city limits in an effort to get lower taxes or to escape city restrictions.

It is common, where area planning is not in force, for each homeowner to drill his own well and install his own sewage disposal system without regard for his neighbor. Sometimes he is forced to do so. This does, however, impose a hazard not only to the water supply but to the sanitary development of the entire area.

Main Extensions

As outlying areas are haphazardly developed and extensions are made for service, developers often install small mains for domestic service only, and many dead ends result. The people served expect, but rarely get, all the conveniences of potable water supplied at good pressures, and in adequate quantities. Later, fire service, which requires larger mains, becomes a necessity. New mains and extensions should not be laid except under a carefully considered plan that takes into account the location of the mains, hydrants, and valves and insures that the material and its installation meet specifications equal to those for the system of which it will ultimately become a part.

Financing Problems

Someone must pay for such extensions—not just their installation, but their operation and maintenance as well. In municipally owned utilities, it is quite customary to assess the cost of the distribution piping against the abutting property owner, if within the taxing district, and to charge a tap-

ping fee or a connection charge sufficient to cover the service and meter installation at the time service is requested. When extensions are made outside the municipal boundaries, other means are generally employed to assess the full costs of the installations against those whom they are to serve.

It is not possible, however, for privately owned water utilities to assess any part of the costs of installation through taxes. Privately owned utilities operate under rules and regulations laid down by various public utility commissions and regulatory agencies. In order not to burden existing customers with the expense of extensions to new customers, the regulatory commissions generally require that a part or all of the costs of such extensions be paid by the individual, group, or real estate developers who desire them. In some areas, the utility is required to put in a specific footage of pipe for each customer with any excess to be paid for by the customers. Some commissions allow deposit agreements to be made whereby the customers pay the cost of the extensions and are refunded an agreed-upon amount for the subsequent attachment of each new customer within a limited period of time, usually not more than 10 years.

In many localities, water districts are formed outside the municipal limits or in sparsely populated areas and take it upon themselves to develop the distribution system and sometimes to purchase water at wholesale and resell it to individual customers.

QUESTIONS

1. How are distribution system records useful in estimating future system demands?
2. What are the four more common methods of making population projections?
3. What is the minimum residual water pressure during flow required by NBFU standards?
4. What is the hydrant distribution required to meet NBFU standards in your town?
5. What is meant by the term, "unaccounted-for water," and how is it determined?
6. What is your utility's policy on extensions of service to outlying areas?

CHAPTER 2

Hydraulics and System Analysis

HYDRAULICS is the general study of the principles and laws governing the behavior of liquids, both at rest and in motion. There are two major divisions of hydraulics, hydrostatics, or the study of liquids at rest, and hydrodynamics, the study of liquids in motion.*

Hydraulic analyses of water distribution systems require a basic foundation in mathematics and engineering. Design work involving major hydraulic analyses and planning must be done by competent hydraulic engineers who are thoroughly familiar with both the theoretical and practical aspects of hydraulics. Such men may be available within the utility, or it may be necessary to hire outside engineering consultants. Some of the fundamental principles of hydraulics should be understood by all who are engaged in the planning, design, or operation of distribution systems.

Hydraulic Properties of Water

Water is not a perfect liquid, although for engineering purposes it may be assumed to be. It has practically perfect elasticity of volume but no elasticity of shape; for practical engineering purposes, it is incompressible; it instantaneously transmits pressure equally in all directions with undiminished force. Fresh water weighs approximately 62.4 lb/cu ft; salt or sea water may be assumed to weigh 64.0 lb/cu ft.

Definitions

A few definitions and simple calculations relating to distribution system hydraulics should be of value:

Hydraulic head (pressure head). Under atmospheric conditions, pressure head is the height to which water will rise in a vertical pipe, open at the top and connected to a closed container, such as a pipeline, under a given pressure. It is generally measured in feet, but may be translated into its equivalent pressure (in pounds per square inch). Thus, 1 psi is equivalent to 2.31 ft of water head, or conversely 1 ft of head is equivalent to 0.433 psi. Table 2.1 lists the hydraulic heads, and their pressure equivalents, in the ranges commonly dealt with in hydraulic analyses.

Measurement of pressure (head) is accomplished by piezometer tubes, mercury gages, pressure differential gages, or commercial pressure gages.

* Some writers prefer "hydrodynamics" as the general term; this, in turn, is broken down into hydrostatics, hydromechanics, and hydraulics (the applied science).

These instruments may be graduated in feet of head or in pounds per square inch of pressure. A piezometer tube consists of a straight tube inserted into a closed container or pipe, normal to the water face, and carried vertically upward to a height sufficient to prevent overflow. The height of the free surface above any defined point in the container varies directly with the pressure at that point. In practice, piezometer tubes are usually filled with heavier liquids, such as mercury, to reduce the height to which they would otherwise have to extend, but the principle is the same as described above.

Hydraulic gradient (grade). The hydraulic gradient, or grade, in hydraulic analysis is an imaginary line connecting two or more points of free water surface which would exist if piezometer tubes were inserted at those points in a given hydraulic system. In other words, it is the profile of the piezometric level along the line.

Quantity of flow. Quantity of flow (Q) is the volume of flowing water in a pipe, conduit, flume, or stream passing a given point in a specific unit of time. The flow may be partly unconfined, as in a flume or open stream, or under pressure, as in a pipe or conduit. Flow may be expressed in cubic feet per second (cfs), gallons per minute (gpm), millions of gallons per day (mgd), or even billions of gallons per day (bgd).

In a pipeline under conditions of steady flow—and assuming no loss of water from the line—the equation of continuity of flow can be written as $Q = A_1V_1 = A_2V_2$, in which A_1 and A_2 are cross-sectional areas of the pipe at two points, 1 and 2, and V_1 and V_2 are the velocities of flow at those points, respectively. Flows can be determined by multiplying the cross-sectional area of the pipe by the average velocity of flow. Cross-sectional areas of circular pipe are easy to compute from the formula for the area of a circle, $A = \pi r^2$, in which r is the internal radius of the pipe, or half the inside diameter.

Torricelli Equation

Average velocities are not as easily or accurately determined in the field. The basic equation for velocity, which applies only for theoretical conditions, is the Torricelli equation, $V = \sqrt{2gh}$, in which g is the acceleration due to gravity (32.2 ft/sec/sec) and h is the head (in feet). This equation may also be written so as to solve for h (called the "velocity head") in the form $h = \frac{V^2}{2g}$.

Bernoulli Theorem

In 1738, Daniel Bernoulli demonstrated a general theorem of water in motion which is perhaps the most important in the field of hydraulics and forms the basis of hydrodynamics. Bernoulli's theorem states, in sub-

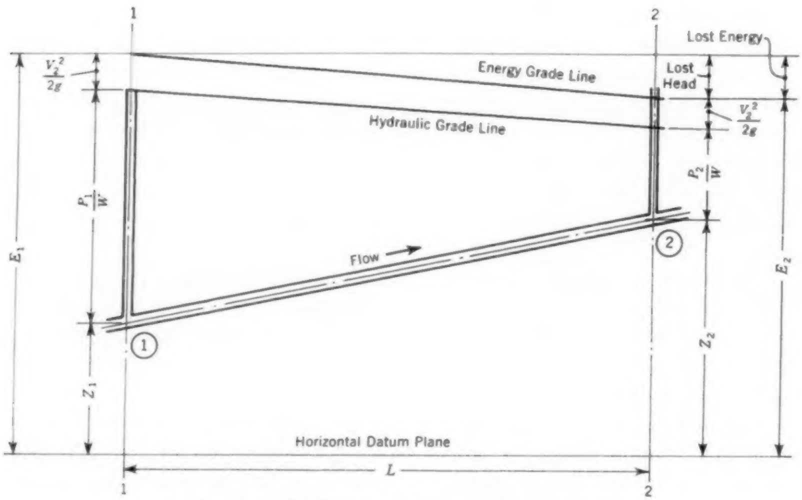

Fig. 2.1. Illustration of Bernoulli's Theorem

TABLE 2.1

Head-Pressure Conversion Table

Pressure to Head				Head to Pressure			
psi	*ft*	*psi*	*ft*	*ft*	*psi*	*ft*	*psi*
1	2.31	100	230.90	1	0.43	120	51.97
2	4.62	110	253.98	2	0.87	130	56.30
3	6.93	120	277.07	3	1.30	140	60.63
4	9.24	130	300.16	4	1.73	150	64.96
5	11.54	140	323.25	5	2.17	160	69.29
6	13.85	150	346.34	6	2.60	170	73.63
7	16.16	160	369.43	7	3.03	180	77.96
8	18.47	170	392.52	8	3.46	190	82.29
9	20.78	180	415.61	9	3.90	200	86.62
10	23.09	190	438.90	10	4.33	225	97.45
15	34.63	200	461.78	20	8.66	250	108.27
20	46.18	225	519.51	30	12.99	275	119.10
25	57.72	250	577.24	40	17.32	300	129.93
30	69.27	275	643.03	50	21.65	325	140.75
40	92.36	300	692.69	60	25.99	350	151.58
50	115.45	325	750.41	70	30.32	400	173.24
60	138.54	350	808.13	80	34.65	500	216.55
70	161.63	375	865.89	90	38.98	600	259.85
80	184.72	400	922.58	100	43.31	700	303.16
90	207.81	500	1,154.48	110	47.65	800	346.47

stance, that in steady flow without friction, the sum of velocity head, pressure head, and potential head is a constant quantity for any particle throughout its course. When friction is taken into account, the definition is modified to state that in steady flow, with friction, the total head at any section is equal to that at any subsequent section plus the head loss occurring between the two sections. This may be seen in Fig. 2.1. The following relationships hold:

1. Energy at (1) is equal to the energy at (2) plus losses, or the total dynamic head H is equal to pressure head (P/W) plus velocity head $(V^2/2g)$ plus various losses.

2. The loss-of-head portion of the equation (Darcy-Weisbach equation) is $h_L = fLV^2/2gd$, in which h_L is the head loss due to friction, f is the coefficient of friction (dependent upon flow velocity and pipe roughness), L is the length of pipe, and d is the inside diameter of the pipe.

3. By substitution, the equation for total dynamic head (all head expressed in feet) thus becomes:

$$H = \frac{P}{W} + \frac{V^2}{2g} + \frac{fLV^2}{2gd} + \text{other losses.}$$

Hazen-Williams Formula

Many researchers working with experimental pipelines have developed similar equations, generally exponential in form, to present the results of flow of water in pipes, but the Hazen-Williams formula has become more generally used than any other in the water supply field. It gives acceptable results provided the coefficient is carefully determined. The formula is:

$$V = CR^{0.63}S^{0.54}0.001^{-0.04}$$

in which V is the velocity of flow in feet per second, C is a coefficient dependent on the interior conditions of the pipe (sometimes called the coefficient of roughness), R is the hydraulic radius or the area of the pipe divided by the wetted perimeter in feet, and S is the slope (H/L) of the hydraulic gradient or head loss, in feet per 1,000 ft of pipe. In a closed pipe of constant diameter, with flow under pressure, $R^{0.63}$ becomes a constant such that $V = CKS^{0.54}$. In other words, the velocity and, therefore, the quantity flowing in a given size of pipe vary directly as the coefficient C and as the 0.54th power of the hydraulic gradient.

Williams and Hazen compiled tables * for varying conditions of roughness, from which numerous charts and nomographs have been made. A Hazen-Williams hydraulic slide rule has been developed, and it is used by many engineers in making hydraulic calculations. Figure A.1–A.23 in the Appendix cover a wide range of pipe sizes, coefficients, and flows in pipelines commonly encountered in the water supply field.

* *Hydraulic Tables.* John Wiley & Sons, New York (1952).

Once any two of the three factors, (1) loss of head per 1,000 ft, (2) the coefficient of roughness of pipe interior, or (3) the flow in the pipeline (in millions of gallons per day), are known, it is possible to determine the third factor from these charts. Each chart has a line showing the velocity head ($V^2/2g$) for flows in pipelines over the range of the graph.

Distribution System Analysis

In practical pipeline problems which involve more than a single main, such as in a complete distribution system or a section of one, three principal methods of hydraulic analysis are commonly used. When only a few pipelines and simple grids are involved or in problems of pumping and storage, graphical solutions first outlined by Freeman * and later expanded by Aldrich † and Howland ‡ may be used. For more complex problems with

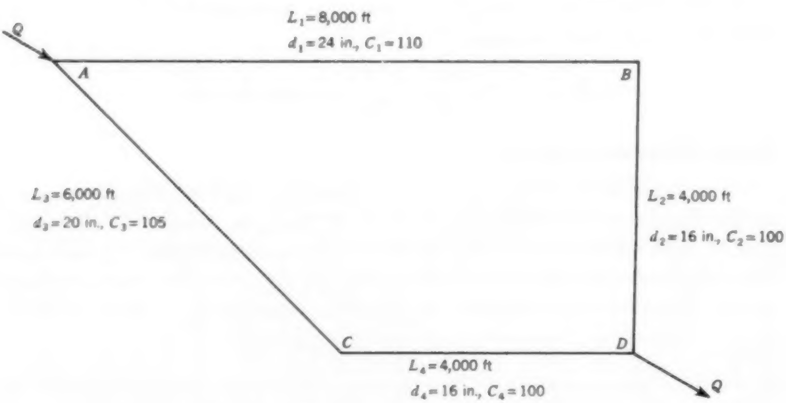

Fig. 2.2. Flow in a Simple Pipe Loop

complicated grid systems and numerous points of supply and withdrawal, the mathematical analysis developed by Cross § or the electrical analyzer developed by McIlroy ‖ must be employed to secure a satisfactory solution. A complicated problem of hydraulic analysis should be referred to expert hydraulic engineers. The basic principles of such analyses, how-

* Arrangement of Hydrants and Water Pipe for Fire Protection. *J. NEWWA,* 7:49 (1892).

† Solution of Transmission Problems of a Water System. *Trans. ASCE,* 103:1579 (1938).

‡ Expansion of Freeman Method for Solution of Pipe Flow Problems. *J. NEWWA,* 48:408 (1934).

§ Bulletin 286, Eng. Expt. Station, Univ. of Illinois, Urbana, Ill. (1936).

‖ Direct-Reading Electronic Analyzer for Pipeline Networks. *Jour. AWWA,* 42:349 (Apr. 1950).

ever, can be demonstrated by the solution of a simple problem. Three methods are illustrated below: (1) the equivalent-pipe, (2) the graphical, and (3) Hardy Cross methods.

Equivalent-Pipe Method

In a hydraulic grid system, the flows must balance at each intersection, and the sum of the losses of head between any two points in the system must be the same through any route the water can travel. Solutions to specific problems usually involve, as a first step, the simplification of intricate arrangements of many pipelines and their combination into one or more equivalent lines. The problem considered here will be the simple pipe loop, *ABCD*, shown in Fig. 2.2.

Assume that it is desirable to replace Loop *AD* with a single equivalent length of 24-in. pipe with a *C* value of 100. The process of determining the equivalent length involves three basic steps, described below:

1. *Equivalent pipe length for Branch* ABD. Assume that there is a flow of 5 mgd through *ABD*. From Fig. A.11, the head loss in 1,000 ft of 24-in. $C = 110$ pipe is 1.19 ft. The loss in *AB* is thus $8 \times 1.19 = 9.5$ ft. From Fig. A.8, the head loss in 1,000 ft of 16-in. $C = 100$ pipe is 10.2. The loss in *BD* is thus $4 \times 10.2 = 40.8$ ft. Because *AB* and *AD* are connected *in series,* the loss in *ABD* equals the loss in *AB* plus that in *BD*, or 50.3 ft. The loss in 1,000 ft of 24-in. $C = 100$ pipe is 1.42 ft. By dividing the loss in *ABD* by 1.42 and multiplying by 1,000, one derives the length of 24-in. $C = 100$ pipe equivalent to *ABD,* or $50.3 \div 1.42 \times 1{,}000 = 35{,}400$ ft.

2. *Equivalent pipe length for Branch* ACD. Assume the same 5-mgd flow through *ACD*. From Fig. A.10, the head loss in *AC* is thus $6 \times 3.15 = 18.9$ ft. As can be seen from Fig. 2.2, *CD* is identical to *BD*. Therefore, the head loss in *CD* is identical to that in *BD*—that is, 40.8 ft. Because *AC* and *CD* are connected in series, the loss in *ACD* equals the loss in *AC* plus that in *CD*, or 59.7 ft. By dividing the loss in *ACD* by the loss in 1,000 ft of 24-in. $C = 100$ pipe (1.42 ft) and multiplying by 1,000, one derives the length of 24-in. $C = 100$ pipe equivalent to *ACD,* or $59.7 \div 1.42 \times 1{,}000 = 42{,}000$ ft.

3. *Equivalent pipe length for Loop* AD. Assume a head loss in *AD* of 50 ft. For *ABD* the equivalent pipe length was 35,400 ft. Thus the loss per 1,000 ft of equivalent pipe is $50 \div 35.4 = 1.41$ ft. From Fig. A.11, the flow at which 1,000 ft of 24-in. $C = 100$ pipe undergoes a head loss of 1.41 ft is 5 mgd. For *ACD*, the equivalent pipe length was 42,000 ft. Thus the loss per 1,000 ft of 24-in. $C = 100$ pipe is $50 \div 42 = 1.19$ ft. From Fig. A.11, the flow at which 1,000 ft of 24-in. $C = 100$ pipe undergoes a head loss of 1.19 ft is 4.56 mgd. The total flow, therefore (flow in *ABD* plus flow in *ACD*), is $5 + 4.56 = 9.56$ mgd. From Fig. A.11, the

loss in 1,000 ft of 24-in. $C = 100$ pipe at a flow of 9.56 mgd is 4.71 ft. By dividing the loss in *AD* (previously assumed to be 50 ft) by 4.71 and multiplying by 1,000, one derives the length of 24-in. $C = 100$ pipe equivalent to *AD*, or $50 \div 4.71 \times 1{,}000 = 10{,}600$ ft.

To verify the above analysis, it is necessary to demonstrate that the head loss in *ABD* equals the head loss in *ACD*, as follows:

a. Loss in *AB* at 5 mgd is $1.19 \times 8 = 9.5$ ft; loss in *BD* at 5 mgd is $10.2 \times 4 = 40.8$ ft; loss in *ABD* is thus $9.5 + 40.8 = 50.3$ ft.

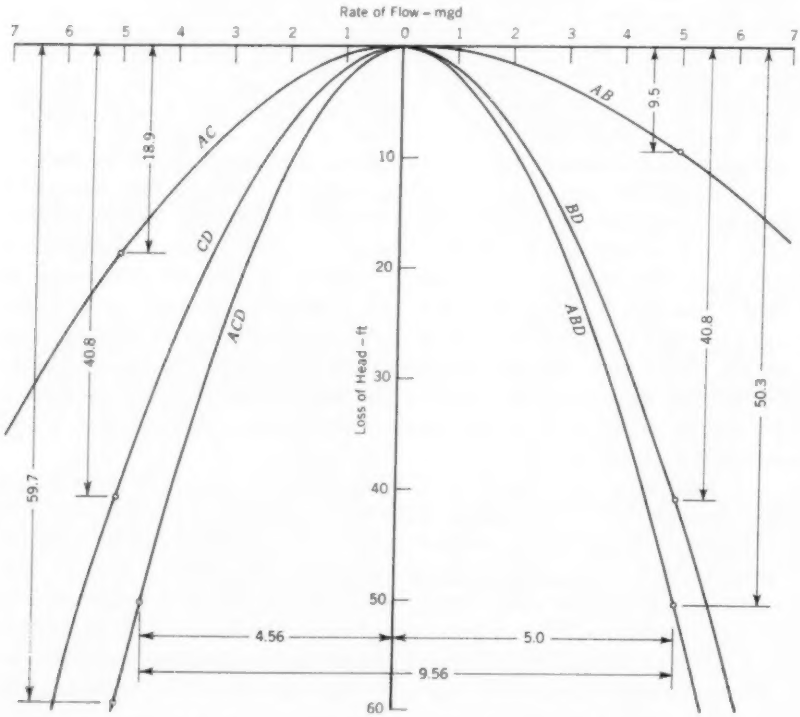

Fig. 2.3. Graphical Solution of Pipe Loop in Fig. 2.2

b. Loss in *AC* at 4.56 mgd is $2.66 \times 6 = 16.0$ ft; loss in *CD* at 4.56 is $8.6 \times 4 = 34.4$ ft; loss in *ACD* is thus $16.0 + 34.4 = 50.4$ ft.

Therefore, because the losses in *ABD* and *ACD* are essentially equal ($50.3 \doteq 50.4$), the analysis is valid.

It should be noted that Steps 1 and 2 above illustrate the method of combining pipelines in series, whereas in Step 3 pipelines in parallel are combined.

Graphical Method

The graphical solution for the pipe loop shown in Fig. 2.2 is given in Fig. 2.3. With abscissas (horizontal dimensions) representing the rate of flow and ordinates (vertical dimensions) the loss of head at those rates, curves are constructed for each section of pipe. The total loss of head for several pipelines connected in series consists of the addition of the ordinates of each section for each rate of flow. This is illustrated by curves for *ABD* and *ACD*. The two branches of Loop *AD*, *ABD* and *ACD*, are connected in parallel. The graphical combination of pipe connected in parallel is effected by adding the abscissas of each pipe at each loss of head, as the loss of head through each branch is the same, and the total flow in Loop *AD* is the sum of the flows of each branch.

As Fig. 2.3 shows, the total flow of the loop as well as the flows in each branch at the indicated loss of head is found by scaling the distance between the curves for *ABD* and *ACD* and their axes. Conversely, the loss of head at any desired flow is found by scaling the required distance between the two curves. In pumping and storage problems, the graphical method of presentation provides visual solutions.

Hardy Cross Method

The Hardy Cross method of network analysis is one of mathematical trial and error in which the flow Q is assumed and the error in the assumed value is computed by the formula

$$\Delta Q = \frac{\sum rQ^n}{\sum nrQ^{n-1}}$$

in which r represents the relative resistance of a pipe and n and Q have the same significance as in the typical flow formula $L = rQ^n$. The method is a process of mathematical convergence in which repeated corrections of Q will produce the desired degree of precision.

Table 2.2 illustrates the Hardy Cross method of solving the simple loop problem shown in Fig. 2.2. First it is desirable to convert all of the pipelines to the same equivalent size of pipeline with the same coefficient, as was done above in the analysis by the equivalent-pipe method. The equivalent lengths of 24-in. $C = 100$ pipe are: Pipe *AB*, 6,700 ft; pipe *BD*, 28,700 ft; Pipe *AC*, 13,300 ft; Pipe *CD*, 28,700 ft.

In Table 2.2 the flow Q is an assumed quantity, h_L is the loss of head in the several pipes, determined by the Hazen-Williams formula, n is 1.85, and Σh_L is the total loss of head in each branch of the loop. To obtain the adjustment ΔQ, to be made in subsequent flows, it is necessary to divide the difference between the loss of head in each branch by $\Sigma \frac{nh_L}{Q}$, or $(23.01 - 19.40) \div 26.17 = 0.138$ ft. In this particular example, two trials

are sufficient to secure a practical balance of heads, producing a flow of 3.138 mgd in *ABD* and 2.862 mgd in *ACD* with a loss of approximately 21.35 ft. This is the same approximate result secured by scaling the distances on Fig. 2.3 between the two curves at the same loss of head.

McIlroy Network Analyzer Method

The McIlroy network analyzer method requires a complex electrical panel board on which a distribution system layout is approximated by wire-and-plug connections with variable resistances set in each line to represent pipe friction (head losses). Although the actual solution of problems by

TABLE 2.2

Hardy-Cross Analysis of Simple Pipe Loop

Datum	Pipe and Equivalent Length* (L)†				$\frac{\Sigma nh_L}{Q}$	Δh_L ft	ΔQ mgd	Σh_L—ft	
	AB (6,700 ft)	*BD* (28,700 ft)	*AC* (13,300 ft)	*CD* (28,700 ft)				*ABD*	*ACD*
Trial 1									
Q—mgd	3.00	3.00	3.00	3.00			0.138		
h_L—ft	3.68	15.72	7.29	15.72		3.61		19.40	23.01
$\frac{nh_L}{Q}$	2.27	9.70	4.50	9.70	26.17				
Trial 2									
Q—mgd	3.138	3.138	2.862	2.862			0.000		
h_L—ft	4.02	17.22	6.77	14.58		0.11		21.24	21.35
$\frac{nh_L}{Q}$	2.37	10.15	4.37	9.42	26.31				

* Illustrated in Fig. 2.2.
† 24-in. $C = 100$ pipe.

this method is relatively simple—once a distribution system is set up on the panel, variable asssumptions of flows, head losses, input and takeoffs are easily made—it requires skill and time to set up the problems, and the equipment is expensive. Few water utilities own such a network analyzer, but a number of installations are available for use on a rental basis in various parts of the country, and they are becoming more numerous.

In the preceding discussions, only simple analyses were illustrated. In any complex hydraulic analysis, the results can only be as good as the basic data upon which the computations are founded, and there are many variables to contend with. The one factor that is most difficult to determine—

and the one most overlooked in practical application of any method of analysis—is the correct, or even approximate, value of the coefficient C, the roughness factor which imposes friction in pipelines. Methods for the practical determination of C in the field are described elsewhere in this manual.

Hydraulics of Leaks

The effect of pressure upon amount of leakage through an orifice may be seen by an analysis of the common equation for flow through an orifice:

$$Q = CA\sqrt{2gh}$$

in which Q is the leakage flow, C is the Hazen-Williams coefficient, A is the area of orifice, g is the acceleration due to gravity, and h is the head on the orifice. Relating the Q under two different pressure heads, h_1 and h_2, and dividing Q_1 by Q_2 yields the relation:

$$\frac{Q_1}{Q_2} = \frac{CA\sqrt{2gh_1}}{CA\sqrt{2gh_2}} = \frac{\sqrt{h_1}}{\sqrt{h_2}}$$

from which one may derive

$$Q_2 = Q_1\sqrt{\frac{h_2}{h_1}}.$$

Thus, if the leakage loss of the system under consideration is 0.5 mgd under a head of 40 psi, when pressures are raised to 60 psi the leakage loss may be expected to become $Q_2 = 0.5\sqrt{60/40} = 0.5\sqrt{3/2} = 0.6125$ mgd.

QUESTIONS

1. What is the basic equation for average velocity of flow in a pipeline?
2. What is the difference between pressure head and velocity head?
3. If, in the pipe loop in Fig. 2.2, the C values of all pipe sections were 100, what would be the equivalent length of 24-in. $C = 100$ pipe for the loop?
4. If the leakage loss through an orifice in a pipeline is 1 mgd at a pressure head of 80 psi, what loss can be expected when the pressure is raised to 100 psi?

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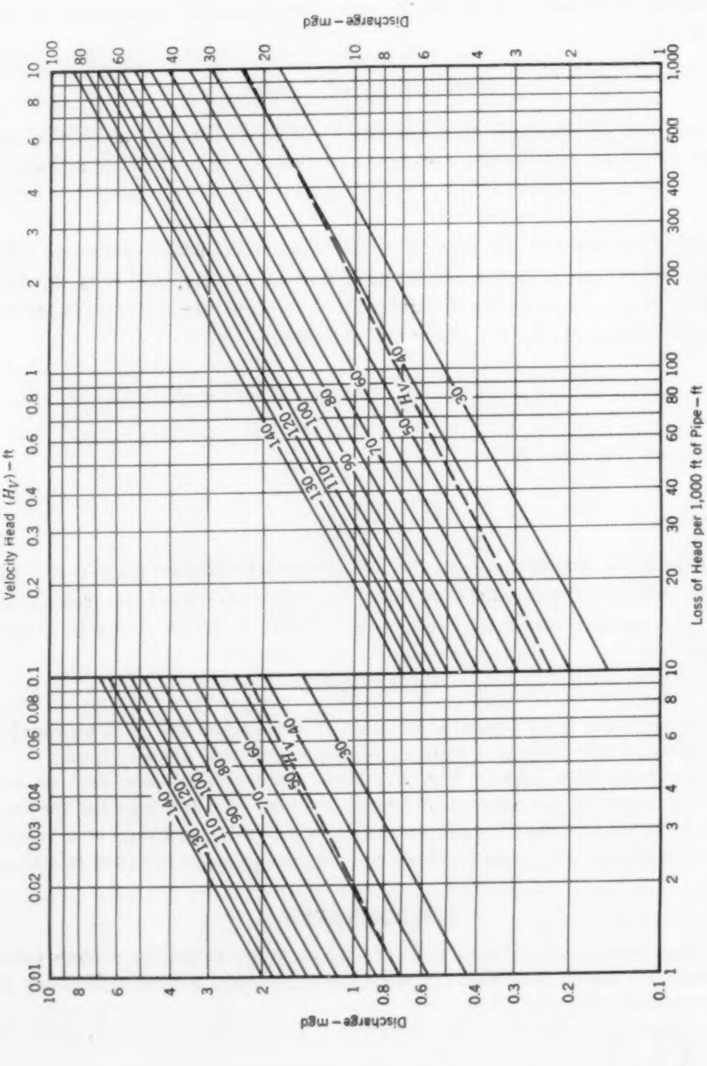


Fig. A.8. Hazen-Williams Flow Chart for 16-in. ID Pipe

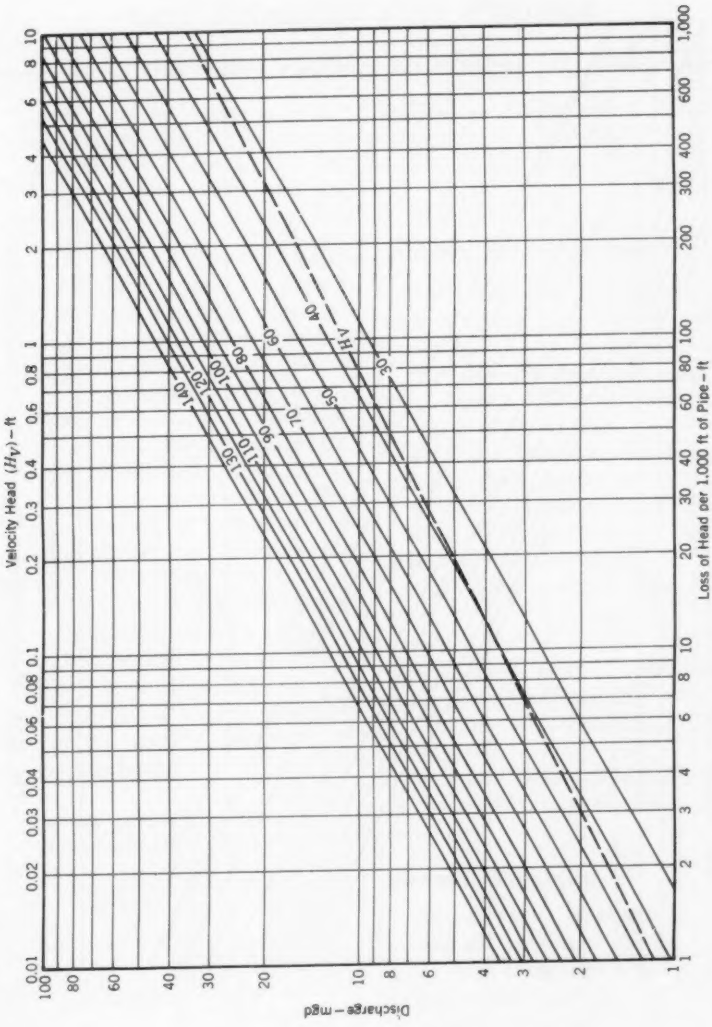


Fig. A.10. Hazen-Williams Flow Chart for 20-in. ID Pipe

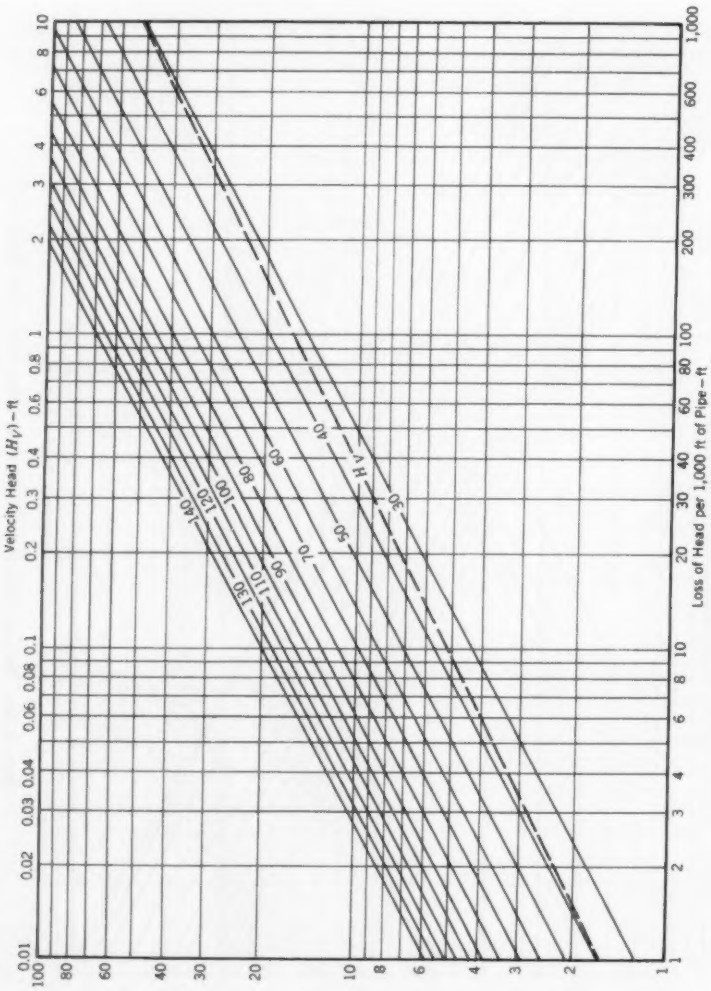


Fig. A.11. Hazen-Williams Flow Chart for 24-in. ID Pipe

Report of the Committee on Professional and Administrative Practice

For the Year Ending December 31, 1960

A report of the activities of the Committee on Professional and Administrative Practice for the year ending Dec. 31, 1960, submitted to the AWWA Board of Directors on Jan. 23, 1961, by Wendell R. LaDue, Chairman.

IN the 1959 AWWA *Directory* (Reference Edition) appears the present organization of the Committee on Professional and Administrative Practice (formerly the Committee on Water Works Administration). The correlating committee consists of the chairman, together with the vice-chairman, the chairmen of each of the four groups into which the subcommittees are classified, the chairmen of pertinent task groups, and advisers of research and development committees. A total of some 140 members of the Association participate in the committee's activities. Committee work and personnel have been subject to continual study and changes are effected to suit changing progress of the work. Present committee personnel are:

Committee on Professional and Administrative Practice

W. R. LaDue, *Chairman*

L. S. Finch, *Vice-Chairman*	J. R. Fleming
L. E. Ayres	M. P. Hatcher
J. J. Barr	H. E. Hudson Jr.
E. L. Bean	J. M. Jester
E. S. Cole	A. P. Kuranz
John G. Copley	R. J. McLeod
G. H. Dyer	R. S. Millar
R. J. Faust	J. H. Murdoch Jr.
	L. N. Thompson

A. A. Ulrich

Inactive Subcommittees

The following subcommittees are now inactive or have not been activated:

4110 M—Constitutional and Statutory Aspects of Municipal Water Utility Organizations

4150 M—Taxation and Revenue Allocation (task group active)

4220 M—Management Relations

4310 M—Construction Equipment and Material Contracts

4320 M—Valuation and Depreciation

4330 M—Cost Trends

4410 M—Water Department Reports (adviser retained)

4420 M—Water Rates (adviser retained)

4430 M—Joint Administration of Water and Sewer Facilities (advisers retained).

General Statement

At the Bal Harbour Conference, numerous pertinent topics stemming from the committee's activities provided subject material for the various sessions. Attendance was good and member interest was unusually high. Increasing activity is maintained in present fields of the committee's work, and expansion is made into other fields

as the Association's program, personnel, and budget will permit, and as the membership requires. The present-day problems of professional and administrative practice are increasing in complexity and importance, and emphasis may shift from one phase to another, with continuing interest.

Subcommittee Activities

Following is a brief summary of the status and work of the several subcommittees for the year 1960, as submitted by the chairmen:

4120 M—Radio and Mobile Communication Facilities for Water Utilities. No specific project is underway at the present time. At Bal Harbour, the chairman, John M. Jester, presented a short statement to stimulate interest in the communications field, abstracted as follows:

During the past 2 years a survey was made of the use of radio facilities in this country. Some 1,200 questionnaires were sent out, with 827 replies being received. Reporting were 506 that use shortwave radio facilities; 192 of the remaining 521 water utilities advised they expected to have such facilities in use by 1963. This involves some 1,100 fixed transmitters and 9,000 mobile units, thus indicating the magnitude of the personnel required for operation and maintenance of this facility in the water utilities. Petitions are before the FCC for additional frequency allotments.

4121 J—National Committee for Utilities Radio. John M. Jester, chairman, has been appointed by NCUR as a member of a special subcommittee on mobile relay. The purpose of this committee is to study and make recommendations in connection with two-frequency operation. The primary activities of this committee during 1960 have been as liaison between AWWA and NCUR legal representatives. Data have been furnished these representatives in connection with briefs filed with the FCC pertaining to frequency assignments and channel splitting. The chairman has also worked in reviewing and suggesting changes and revisions to the NCUR guide to operating practices.

TABLE 1

Safety Awards, 1957–59

Year	No. of Awards Earned			Total Employees	Total Man-Hours of Exposure	Number of Lost-Time Injuries	Injury Frequency Rate
	Merit	Progress	Honor				
1957	436	69	33	20,383	40,767,208	435	10.7
1958	879	61	50	27,449	55,492,303	482	8.7
1959	841	62	49	27,332	55,197,168	489	8.9

4130 M—Water Used in Air Conditioning and Other Refrigeration. A report of the survey of ordinances and regulations was completed in 1957. The committee, in general, keeps abreast of developments, which seem to be favorable to reasonable water use. No unusual problems have developed.

4140 M—Water Use in Fire Prevention and Protection. This committee is at present functioning on a standby basis, observing the effects of the National Board of Fire Under-

writers revised rules and regulations. The committee urges that members of the Association review their own situation in the light of the changes and that members give careful attention to new rating surveys. It is requested that members of the Association who have had surveys made under the revised rules and regulations send copies of the results to the committee for its information and review.

4150 M—Taxation and Revenue Allocation. Although this committee is not yet active, nevertheless the general office of the Association has had occasion to present to governmental highway agencies the water utility viewpoint on the important subject of acceptance and allocation of costs and payment of charges due to relocation of facilities proposed by highway authorities. This problem will remain constantly before water utility managers, so long as a stepped-up program of super-highways and turnpikes develops and continues to present itself, encouraged by continuing federal and state highway program legislation and recommended implementation. Many states have passed legislation indicating opposite and varying viewpoints on this important subject. It behooves each water utility manager to maintain constant vigilance of local, state, and national developments in order to secure equity.

4160 J—American Sanitary Engineering Intersociety Board (Joint Committee for Advancement of Sanitary Engineering). Activities of the member groups have resulted in the establishment of the American Academy of Sanitary Engineers. Entrance is by examination in fundamental preparation and proficiency in the various fields of sanitary engineering. More than a thousand persons have been certified as diplomates, thus giving public recognition to the profession so closely allied with and so necessary to the water utility field.

4230 M—Compensation of Water Utility Personnel. The committee is now in the process of finalizing a questionnaire on fringe benefits extended to employees of water utilities in the United States and Canada. It is planned for this questionnaire to be mailed shortly. The questionnaire will survey both fringe benefit policies and the costs of these policies. Costs will be expressed in terms of cents per hour and the percentages of total payroll.

4240 M—Pension and Retirement Plans. The committee is on a standby basis awaiting final determination of requirements set up by the Aims and Objectives Committee.

4250 M—Safety Practices. The committee is following through on AWWA's safety program. No specific tasks of any consequence face the committee at the present time, except to keep the program rolling and see to it that more utilities participate each year. Section committees are unusually active and aggressive. The record of the safety program continues to grow, and the statistical evidence bears out this statement. In 1959, for example, 952 AWWA safety awards were issued. The results being produced by the safety program are remarkable and a source of pride for everyone who participates. Table 1 provides salient information to compare the results of the past three years.

At Bal Harbour in June 1960, the Wendell R. LaDue Safety Awards were issued. In Class Size 1 (1–9 employees) the award was won by the Knoxville (Tenn.) Suburban District with a record of no lost-time injuries since

1950. In Class Size 2 (10–100 employees) the award was won by the Brookline (Mass.) Water Dept., with a record of no lost-time injuries in 108,000 man-hr of exposure during 1958. In Class 3 (more than 100 employees) the award was won by the Knoxville (Tenn.) Bureau of Water with a record of no lost-time injuries in 489,085 man-hr during 1958.

The safety manual has continued to be a best seller of the Association. It appears that, at last, the water industry has become safety conscious. The committee has a continuing program to reduce injuries in the industry. On the section level there are safety committees, and a section award plan is being observed annually; the Wendell R. LaDue Awards are presented at the Association's Annual Conference. Three years of the safety award plan have been completed, and now this committee can evaluate the results and determine new approaches in order to meet its objectives.

Report No. 166—"Injuries and Accident Causes in Water Supply Utilities"—of the Bureau of Labor Statistics of the US Department of Labor is a very real service to the industry. The report contains a complete analysis of data collected by bureau representatives during visits to 98 water utilities in cities of more than 100,000 population. The report answers many questions such as:

1. What types of injuries are most frequently experienced in the industry?
2. What are the most common causes of injury-producing accidents?
3. What are the principal hazardous working conditions?
4. What are the principal unsafe acts?

The summary of this report appeared in the January *Willing Water*. This report serves as an excellent guide for planning and efforts in preventing injuries in the water supply industry.

4260 M—Education. The manual on distribution systems has been written and is being prepared for serial publication in the JOURNAL. The text of the manual on water treatment is largely prepared and should be submitted early in 1961. The manual on source of supply is at least 50 per cent written, and the other portion is now being prepared. It is hoped that the latter will be available for publication in early 1962.

4270 J—Joint Committee on Certification of Water Utility Personnel. The Association's committee works with committees from CSSE and WPCF in this field of certification. Progress in liaison is reported. An interim report was completed in the spring of 1960 and copies were distributed to the members of the Board at the Bal Harbour Conference. It is planned to have a meeting of the chairman of the committee and the new members representing WPCF in Washington during 1961, so that their past activities can be coordinated and unfinished work of the full committee assigned to groups of one or two persons. As CSSE does not meet again until 1962, it is expected that the final report of the AWWA-CSSE-WPCF group will not be available until the spring of 1962.

4340 M—Water Main Extension Policy. This committee is considering plans for reactivation in the light of the growing demands of expanding populations, both urban and suburban.

4430 M—Joint Administration of Water and Sewer Facilities. With the completion of its final report in 1959, the committee was placed on the inactive basis with L. N. Thompson and R. J. McLeod as advisers.

4440 M—Residential and Commercial Use of Water. The committee is now revising and consolidating the reports it has made in the past 3 years into one final report on residential water use, which is to be submitted to the JOURNAL for publication. The committtee has sponsored several papers which may appear on the program of the 1961 Annual Conference. The committee feels that continuing activity will be necessary in the field of residential use. Meanwhile, other trends seem to be taking place in commercial and industrial use that deserve investigation. The committee will concentrate on these in the interim.

4450 M—Revenue-Producing Water. This committee is on a standby basis and works closely with the Water Distribution Division. It continually watches developments in contributions to the literature in the field of interest.

2210 M—Task Group on Job Classification. This is a task group in the province of the Management Division. It is helpful to Committee 4230 M (Compensation of Water Utilities Personnel). For the past year it has worked closely with the US Department of Labor Bureau of Employment Security on the subject of job definitions, with very gratifying results.

The new *Dictionary of Occupational Titles* will follow methods, style, technical details, and form developed over the year. Although no two utility operators could possibly come to complete agreement on all job descriptions, it is felt that a substantial majority will find the work basically sound and of excellent foundation material upon which to build and write definitions and descriptions that recognize the details of organization and operation at their plants. In addition to the job descriptions included among those the committee has reviewed, many of those listed among other industries will apply to the water supply industry. The new dictionary is going to be a material improvement over the 1949 Edition, which listed only thirteen job titles under "Water Works." The new one will list between 200 and 300.

2220 M—Task Group on Review and Redevelopment of a Rating Scale for Water Utilities. The six subgroups, 2221 M–2226 M, have been very active in preparing statements of standards in the various phases of the problem.

2230 M—Committee to Cooperate With NARUC Committee on Revision of System of Accounts for Water Utilities. This committee is now on a standby basis. It is still felt that the Association will soon need a committee on accounting practices if it is to maintain any stature in this field. It is reported that the accounting committee of NARUC is presently considering revisions and changes in accounting requirements, more particularly as they apply to retirement units. On invitation by the chairman of the NARUC committee, a small group of representatives of private water company interests was organized to discuss retirement units with the NARUC committee.

2240 M—Committtee to Cooperate With NARUC Committee on Proposed Rules and Regulations Governing Water Service. The current work of the committee is completed, except to be on the lookout for possible new rules. Therefore it is believed that the committee should be kept active so that it may be helpful in keeping members of the Association informed of developments.

1961 Conference

Topics timely for presentation at the 1961 Detroit Conference are under dis-

cussion by committee members and with others of the Association interested in the Conference sessions, particularly the members of the publication and program committees, and the officers of the several divisions. Many of the best division programs stem from administrative problems.

Recommendations

The attention of the Board is directed to necessary enlarging of the activities of the Committee on Professional and Administrative Practice from time to time along current lines. There are numerous projects which cannot be handled efficiently strictly on a member-committee basis. They involve a large amount of research and can best be handled as staff projects. The Association's budget can be supplemented by outside funds, especially when a project involves items in which manufacturers or industries are vitally concerned. Such subcommittee activities which might be considered as projects requiring staff aid are:

4110 M—Constitutional and Statutory Aspects of Municipal Water Utility Organization (now inactive)

4150 M—Taxation & Revenue Allocation (informal task group now studying highway changes)

4220 M—Management Relations

4320 M—Valuation and Depreciation

4330 M—Cost Trend

4440 M—Water Use

2220 M—Rating Scale.

Other activities that might be considered pertain to standards of water utility operation and to water quality.

It is the studied aim of the Committee on Professional and Administrative Practice to proceed deliberately, acting upon, anticipating, and developing obvious member demands and expanding interests in a long-time policy of continuing and current problems; to maintain close cooperation with the Committee on Standardization and the Committee on Technical Program; and to encourage obvious member participation in task groups of the divisions. The large amount of invaluable assistance required of and performed by Association members and personnel is continuously recognized with appreciation. Appreciation is hereby extended to all section and committee chairmen and committeemen for the many unselfish services rendered. The ever valued counsel, consideration, and guidance of the members of the Board of Directors are gratefully acknowledged.

Report of the Committee on Standardization

For the Year Ending Dec. 31, 1960

A report of the activities of the Committee on Standardization for the year ending Dec. 31, 1960, submitted to the AWWA Board of Directors on Jan. 23, 1961, by Louis R. Howson, Chairman.

THE Committee on Standardization (formerly the Committee on Water Works Practice), through its many subcommittees, maintained its usual high level of activity during 1960. Although no new standards were published, revised editions of two standards—for fabricated, electrically welded steel pipe (C201) and mill-type steel pipe (C202)—were completed and appeared in the November 1960 JOURNAL.

Perhaps the most noteworthy accomplishment during 1960 was the appearance, in October, of the eleventh edition of *Standard Methods*. Now titled *Standard Methods for the Examination of Water and Wastewater*, the eleventh edition is approximately 25 per cent larger than the tenth and is a complete revision of the old text. Credit is due the 125-man Standard Methods Committee and, particularly, its chairman, Mike Taras, for their 4 years of untiring effort in producing the final manuscript of the methods for chemical and physical examination of water.

Detailed resumes of standardization, research and development, and other committee activities are presented below.

Standards

Cast-iron pipe and fittings. ASA Committee A21 is reviewing all seven of the AWWA-sponsored cast-iron pipe standards issued under ASA procedure (AWWA C101, C102, C104, C106, C108, C110, and C111). Among the subjects under consideration are bituminous coatings, single-gasket joints, allowances for water hammer, factors of safety in the design of fittings, and an expansion of C110 (Short-Body Fittings) to cover larger sizes. The committee is considering the inclusion of specifications for asbestos-cement pipe fittings. Work on C110 and C111 is well advanced, but has been delayed pending special investigations of factors of safety and allowances for water hammer. A meeting to discuss these items has been called for Jan. 20, 1961. [No action was taken.]

Vertical-turbine pumps. The vertical-turbine pump standard (A101) has been revised. As a result of the revision, a new section on submersible pumps is now included. The revised standard, approved by the Board on May 15, 1960, has been submitted to ASA for approval. [ASA approved the standard on Jan. 31, 1961; it was published in the March issue of the JOURNAL.] The committee (ASA B58) is actively working on a field test code for eventual inclusion in A101.

Deep wells. At Bal Harbour, the Board of Directors resolved that Com-

mittee 6310 J be reactivated to develop a revised standard to include the recommendations of the California Section concerning double-wall casings and rotary gravel types of wells. The committee has been reactivated under the chairmanship of James C. Harding, who also was chairman of the previous committee.

Ferric sulfate. A new standard for ferric sulfate (B406) has been prepared under the direction of Elwood L. Bean. It is recommended that the new standard be approved by the Board of Directors. [The Board approved the standard as tentative; it will be published in the May 1961 issue of the JOURNAL.]

Fluoride chemicals. Revised standards B701 (Sodium Fluoride), B702 (Sodium Silicofluoride), and B703 (Fluosilicic Acid) were approved by the Board on May 15, 1960. Publication of these standards was delayed because of editorial changes and they did not appear in 1960. [The three standards were published in the January 1960 JOURNAL.]

Other chemicals. Revisions to B600 (Powdered Activated Carbon) are nearing completion and will include modern methods of analysis. Work has been started on a standard for anhydrous ammonia. The committee (AWWA 7311 P) expects to complete work on both these standards in 1961, but no report will be made at the 1961 Conference.

Steel pipe. The second edition of AWWA C201 was approved as "Tentative" on May 15, 1960 and published in the November 1960 JOURNAL. The revised edition covers fabricated electrically welded pipe of all sizes, whereas the first edition covered only sizes 30-in. and larger. The new designation is C201–60T (Fabricated Electrically Welded Steel Water Pipe).

The second edition of AWWA C202 was also approved as "Tentative" on May 15, 1960 and published in the November 1960 JOURNAL. The revised edition covers mill-type pipe of all sizes, whereas the first edition covered both fabricated and mill-type pipe in sizes up to but not including 30-in. The new designation is C202–60T (Mill-Type Steel Water Pipe).

A report of AWWA Committee 8310 D, entitled "Design and Installation of Steel Water Pipe," consolidates useful information on steel pipe for convenient reference. It will be published in the JOURNAL in a number of installments, beginning early in 1961, with the expectation that it will be reprinted as a unit when complete. In recognition of the fact that some of the concepts included in the discussion are new to the field, comment and discussion by readers will be encouraged. All pertinent discussion will be published and made part of the reprint.

Work continued on proposed revisions to C205 (Cement Mortar Protective Coatings for Steel Water Pipe of Sizes 30-in. and Over). Revisions to C203 (Coal-Tar Enamel Protective Coatings for Steel Water Pipe) are nearing completion.

Reinforced concrete pipe. AWWA Committee 8320 D completed and approved a report on "Concrete Water Pipe Installation" which is ready for submission to the Committee on Standardization, except for photographs and sketches. The committee expects to submit its complete manual for approval in 1961.

Because large quantities of pretensioned (thin-wall prestressed) concrete cylinder pipe are being used throughout the Southwest, the Pacific Coast area, and Canada, it is believed that this pipe has a field of its own and that there should be an AWWA stand-

ard for it. It is recommended that the Board approve the preparation of such a standard, that the project be assigned to the present Committee 8320 D, and that the chairman of the Committee on Standardization be given authority to add personnel to the committee if desirable. [The Board approved.]

Asbestos-cement pipe. Revised Standard C400 (Asbestos-Cement Water Pipe), previously approved by the Committee on Standardization, has been returned to Committee 8340 D to review (1) the section limiting the uncombined calcium hydroxide to 2 per cent, and (2) the section requiring that the pipe be tested in the country in which it is to be used. The Antitrust Division of the US Department of Justice objected to these sections last May just prior to the Bal Harbour Conference on the basis that they might be in violation of restraint-of-trade provisions of federal law and certain trade agreements with foreign countries. Later, the Department of Justice withdrew its objection to the restriction on uncombined calcium hydroxide.

Committee 8340 D has also been instructed to produce a more technical standard comparable to the standards on competitive products, in which consideration is given to strength of material, unit stresses, loading conditions, and laying conditions, so that the pipe may be designed to fit conditions that will be encountered in the field.

The Committee on Standardization believes that there is a need for a standard for installation of asbestos-cement water mains. It recommends that the Board authorize the creation of such a standard and that the task be assigned to the present Asbestos-Cement Pipe Committee 8340 D. [The Board approved.]

Fire hydrants. Committee 8510 D was reactivated and reorganized in March 1960 to review AWWA C502 (Fire Hydrants for Ordinary Water Works Service). A progress report will be made at the 1961 Conference, if desired.

Valves. Tentative AWWA Standard for Gate Valves for Ordinary Water Works Service (C500) was revised by Committee 8530 D and approved by the Committee on Standardization. It is recommended that the Board of Directors approve the revised document and advance it to "Standard" status. [The Board approved.]

Committee 8530 D considers that its work has been completed except for the important job of writing a standard for corrosion-resistant linings. The determination of suitable lining materials still requires a great deal of research by others.

Meters. AWWA Committee 8610 D has revised AWWA C700 (Cold-Water Meters—Displacement Type). The revised standard was approved by the Committee on Standardization, and it is recommended that the Board of Directors approve the revisions at this time. [The Board approved the standard as "Tentative."]

Committee 8610 D will now begin work on review of the other AWWA standards for cold-water meters—that is C701 (Current Type), C702 (Compound Type), C703 (Fire Service Type), and C704 (Current Type—Propeller Driven).

The Standardization Committee chairman and AWWA staff members attended two meetings in the Bell Telephone Co. New York offices where it was revealed that equipment is presently available to permit remote reading of meters over telephone circuits. Even though costs are prohibitive at present and may continue to

be so in the future, Bell Telephone officials expressed confidence in their ability and that of the meter manufacturer eventually to overcome the cost barrier. Representatives of four of the five United States meter manufacturers attended the second of these meetings. Representatives of the fifth manufacturer were unable to attend because of Hurricane Donna.

Steel standpipes and elevated tanks. Since the approval of AWWA D100 (Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks), Committee 8710 J has made interpretive rulings in four cases involving the standard. The committee now has a work list of about fifteen possible revisions to the standard. The committee hopes to resolve these items and to submit the revised standard in time for it to be considered by the Board of Directors in January 1962.

The committee has completely rewritten D102 (Painting and Repainting Steel Tanks, Standpipes, Reservoirs, and Elevated Tanks) and has submitted it to the individual committee members for formal review.

Research and Development

Artificial ground water recharge. A report of Task Group 2440 R, "Developments in Artificial Ground Water Recharge in the United States," was published in the September 1960 JOURNAL. The group expects to develop a series of reports on the technical aspects of artificial ground water recharge and, eventually, present them as a manual. The first such report, "Purpose of Artificial Recharge," was published in the October 1960 JOURNAL.

Underground waste disposal and control. The report of Task Group 2450 R, "Survey of Ground Water Contamination and Waste Disposal Practices," giving the results of a national questionnaire survey in 1960, was published in the October 1960 JOURNAL. The results of earlier surveys made in 1952, 1955, and 1957 had been published in the October 1957 JOURNAL. The 1961 program of the group will include a review of experimental work concerned with the travel of detergent solutions from septic tank sources and its relation, if any, to the travel of pathogenic organisms.

Operating experiences under new water laws. The recently reorganized AWWA Task Group 2460 R will make its first formal report at the 1961 Annual Conference. Activities include collecting source data on water resources, operating experience under existing water laws, and significant new laws under consideration.

Analytical methods for detergents. Task Group 2662 P prepared, for publication in the eleventh edition of *Standard Methods,* two tentative methods of analysis: (1) the methylene blue process, a usable rough method; and (2) the infrared process, a good "referee" method.

A research project for a better method of analysis for ABS, under the direction of Richard S. Juvet Jr. at the University of Illinois, and financed by the National Institutes of Health, is to terminate on Feb. 1, 1961. A final report will be submitted shortly thereafter. The method developed will be put through laboratory performance tests to determine workability.

Other 1961 activities will be to request continuation of the above research project with a change in emphasis from ABS to nonionic surfactants. The nonionics have increased from 10 per cent to 26 per cent of the domestic market in the last 2 years, and there is

at present no analytical method for determining small amounts of nonionic surfactants in water. The task group expects to report to the 1961 Conference.

Biological infestations. The article, "Questions and Answers on Biologic Infestations," in the "Notes and Comment" section of the August 1960 JOURNAL, was based on typical questions from operators confronted with problems of biologic infestations. Task Group 2670 P participated in preparation of the "Operators Identification Guide to Animals Associated with Potable Water Supplies," an article in the December JOURNAL by Ingram and Bartsch of the Robert A. Taft Sanitary Engineering Center. The group also assisted in defining the scope of an AWWA-sponsored research project on nematodes, which will be performed by Richard S. Engelbrecht, associate professor of sanitary engineering at the University of Illinois, provided a grant-in-aid is forthcoming from the National Institutes of Health.

Cold-water corrosion of copper. After Task Group 2690 P made its preliminary survey of copper water services, "Cold-Water Corrosion of Copper Tubing," published in the August 1960 JOURNAL, the Board authorized a committee to "evaluate Type K and Type L copper water tubes for water service lines." Such a committee was activated in 1960. It is collecting data on corrosion experience with copper pipe installed for service lines. The committee will also attempt to determine the factors considered in developing a standard for Type K tubing.

Diatomite filtration. Task Group 2710 P sought and obtained a 3-year grant of $56,000 from the National Institutes of Health to Iowa State University, effective Oct. 1, 1960, for a research project on design requirements for municipal diatomite filters. Liaison was established with the task group of the National Swimming Pool Institute and the subcommittee on filtration of American Health Association's joint committee on swimming pools.

Each of the members of the group completed certain phases of the work in the area of diatomite filtration.

The group would like to have a half-day session at the 1961 Conference devoted to diatomaceous-earth filtration. [As the program was already full, the session has been postponed until the Philadelphia meeting.]

The group feels that it should remain at work for several more years. It feels that it is becoming truly effective in its own work and in its cooperative efforts with other similar groups attempting to establish design requirements and standards for filters.

Filtrability index test. The activity of Task Group 2720 B consisted of a search of foreign literature for new avenues of approach. They plan to continue exploration of procedures. No report will be made to the 1961 Conference.

Ion exchanger test procedures. Task Group 2750 P worked with ASTM Committee D19, Subcommittee Task Group 1, to develop the ASTM "Tentative Method for Sampling and Testing Cation Exchangers Operating in the Sodium Cycle." Future work will consist of cooperation with ASTM on "Tentative Methods for Cation Exchanger Test Procedures—Hydrogen Cycle."

Viruses in water. The activities of Task Group 2760 P have included a survey of pertinent literature on viruses in water and a survey, by questionnaire, of the state and provincial

health departments in the United States and Canada, requesting information on suspended waterborne virus disease outbreaks. The group's 1961 Conference report will summarize the replies to the questionnaire and will probably include excerpts or condensations from a selected collection of pertinent publications on viruses in water.

Saline-water conversion. AWWA Committee 2770 P was formed in 1960 for the principal purpose of keeping AWWA informed on progress in saline-water conversion. The committee will report to the 1961 Conference.

Water line crossings of highways and railroads. The new committee on highway and railroad crossings is just getting organized for its project "to gather and disseminate information on the design and specifications of pipeline crossings as required for railroads and highways, including standard construction of pipelines laid on rights-of-way of and parallel to railroads and highways."

Other Committee Activities

Spillway design and channel capacity. The task of AWWA Committee 8120 D is the production of a manual on spillways, including sections on: (1) methods of selecting design floods, with explanations; (2) unit hydrograph methods; (3) explanation and appraisal of probability methods; (4) excerpts from and references to federal and other compilations available as aids in the selection of design floods; (5) influence of upstream storage; (6) improvement of existing dams; (7) occupancy of downstream flood plains; (8) investigation of backwater and downstream flooding; (9) and notes on important principles of construction. A complete topical outline has been developed and parts assigned to the various committee members to submit drafts before its meeting in March 1961.

Pipe flanges and fittings. The 1960 addendum to ASA B16 (Steel Pipe Flanges and Flanged Fittings) is nearing completion. Projects completed include cast-bronze, solder joint drainage fittings.

Steering Committee on National Conference on Water Pollution. AWWA's representative attended meetings in Washington, D.C., in June, August, and November, to prepare the program for the national conference that was held in Washington on Dec. 12–14. The committee suggests that AWWA continue its interest and active support of the conference.

Asbestos-cement products. The two AWWA representatives on ASTM Committee C17 attended a meeting of Subcommittee VI (Asbestos-Cement Pipe), in Buffalo, N.Y., on Nov. 29–30, to reconsider ASTM C296 (Specifications and Methods of Test for Asbestos and Cement Pressure Pipe). The subcommittee voted to raise the allowable limit on the amount of uncombined calcium hydroxide from 2 per cent to 3 per cent. The subcommittee also voted not to change the note in the specifications requiring that foreign pipe be tested in the country in which it was to be installed. The subcommittee was reconsidering these two items because the Antitrust Division of the US Department of Justice had notified ASTM that these two items might be in violation of restraint-of-trade provisions in federal law and in violation of trade agreements with foreign countries.

Electrical grounding practices. The AWWA representative attended the first meeting, on Nov. 18, of NACE Task Force Committee T-4A. NACE Committee R30 will advise the chair-

man of T-4A of projects needing attention and provide data as needed. The AWWA representative plans to attend the NACE national convention in Buffalo, Mar. 13–17, 1961.

Graphical symbols, designations, and abbreviations. The ASA committee reviewed one set of proposed standards for graphical symbols (ASA Y32) and proposed revisions for ASA standard for abbreviation for use in text (Y1.1) and for use on drawings (Y1.2). New standards are expected to be ready for approval during 1961.

Code for pressure piping. ASA Committee B31 and several of its subcommittees held meetings during 1960 in regard to preparation of a pressure piping code. No discussion was held in connection with water pipe, however.

Pipe threads. Two new standards were approved and are available through ASME. The standards are ASA B2.1 (Pipe Threads—Except Dryseal) and ASA B2.2 (Dryseal Threads).

Industrial cooling towers. The AWWA representative on Committee B76 was invited to serve on its Subcommittee 2 (Materials of Construction), which has been expanded to include Subcommittee 5 (Water Treatment) because of overlapping of the areas of interest of the two committees. Subcommittee 2 will review all materials presented for consideration; consider the effect and tolerable limits of temperature and chemical content for water flowing over a tower; review existing standards for possible use in ASA standards; consider modifications and limitations necessary for field-erected or factory-erected towers. Areas of task group activities will include lumber, wood preservatives, asbestos-cement, plastics, metals, and ceramics.

Heat exchangers for chemical industry. The AWWA representative on ASA B78 is a member of Subcommittee 2, whose activities are directed toward standardizing internal parts and arrangements for heat exchangers. Subcommittee 3 has had to wait for information from Subcommittees 1 and 2 before starting on its own work. Differences that developed between representatives of the chemical and refrigeration industries were resolved in the decision to make standards developed for one industry applicable to the other as well.

Revision of USPHS Drinking Water Standards. A further investigation was made on phases of the problem of revision of the USPHS Drinking Water Standards which included studies of the toxicity of herbicides and pesticides.

A study was also made of compliance with the present standards and the effects of the present certification program. The results of the study indicated that the public expects high quality water in addition to safe drinking water and that it will no longer tolerate complacency in regard to quality.

A report was submitted at Bal Harbour and published in the September 1960 Journal.

Work is nearly complete on toxicity levels of chlorinated hydrocarbon and organic phosphate insecticides as well as the radiological limits the committee hopes to include in the new standards.

Final approval of the revised standards is expected at the committee's final meeting in mid-February 1961. The committee can make its final report at the 1961 Detroit Conference, if such report is desired. [No Board action taken.]

The AWWA representative is also a member of an informal advisory

group established by USPHS to implement a study project on quality control procedure on interstate-carrier water supplies.

Standpipes and outside protection. The NFPA committee worked on a standard for indicator posts and on a pamphlet entitled "Fire Department Operations in Protected Properties." Future activities of the committee will be to complete these projects and a revision of the NFPA Standard for Standpipes and Hose Systems.

NACE Inter-Society Corrosion Committee. The AWWA representatives' function to date has been to audit the yearly report of the committee.

ASTM Task Group on Ion-Exchange Materials. ASTM Committee D19 completed and approved a "Tentative Method of Test for Operating Performance of Cation Exchange Materials—Sodium Cycle."

Joint Committee on Uniformity of Methods of Water Examination. The report of AWWA Committee 8932 J (JCUMWE) was released in May 1960 for publication by each of the member organizations. It appeared in the August 1960 JOURNAL. The committee issued preliminary recommendations on sulfate, uniformity of reagents, acidity, and alkalinity now being studied in the committees of member organizations. AWWA is favorably disposed toward the sulfate recommendations; has some reservations about the recommendations on uniformity of reagents; and has serious reservations about the acidity and alkalinity recommendations.

The committee activated new panels on the following subjects with AWWA representation on each: ammonia, fluoride, lead, turbidity, conductance, calcium and magnesium, and phosphorus. Under consideration are panels for nitrite, carbonate, bicarbonate, carbon dioxide, residual chlorine, and chromium. The committee does not expect to report at the 1961 Conference.

Standard Methods. The Joint Editorial Committee on the Eleventh Edition of Standard Methods (AWWA Committee 8931J) completed final revision of the text of the eleventh edition, which was published in October 1960. Approximately 20 per cent larger than the tenth edition, the new volume represents a complete revision of the old text. Many new methods have been added and others have been changed to conform with advances in analytical techniques and equipment. Also new sections have been included to provide information on radiological methods and on the bioassay of wastes as related to their toxicity to fish.

Future work of the committee will be to consider errors or criticisms that turn up in the eleventh edition and to organize for beginning work on the twelfth edition. No report will be made at the 1961 Detroit Conference. [A summary of corrections to the eleventh edition is given on p. 515 of this issue.]

Plastic Pipe and Fittings. AWWA is represented on ASA sectional committees B16 (Non-Metallic (Plastic) Pipe Fittings) and B72 (Plastic Pipe), and an ASTM committee on thermoplastic pipe and fittings. The function of 8350 D has been to consult with and advise AWWA representative on proposed standards and other activities of the ASA and ASTM committees.

Report on Publications

For the Year Ending December 31, 1960

A report on the publishing activities of the Association for the year ending Dec. 31, 1960, submitted to the AWWA Board of Directors on Jan. 23, 1961, by Eric F. Johnson, Director of Publications.

BOWING in during 1960 was the new edition—the eleventh in 55 years—of *Standard Methods for the Examination of Water and Wastewater,* together with some new public relations aids. Otherwise the year was unexceptional or a little worse, with advertising and publication sales, like business in general, dipping below 1959 recods. Meanwhile, the staff was concentrating on things to come in 1961: on two new manuals—one on animal identification, which was published as an article in the December 1960 JOURNAL, and the other on distribution, which will be serialized in the JOURNAL beginning in this issue—on the steel pipe report, serialization of which is expected to begin in June, and on setting up revision committees for the *Accounting Manual* and *Water Quality and Treatment.*

Even though it was unexceptional, 1960 produced a solid amount of publication activity.

1. The Journal

A detailed picture of JOURNAL contents, costs, and income for the past 5 years is presented in Tables 1 and 2.

a. Contents. Text pages during 1960 were almost exactly on the budget figure of 1,650, but, because of a drop in advertising, the overall size of the JOURNAL was 96 pages less than estimated.

Text articles followed very much the same pattern as they did in 1959, except that, because of the lateness of the annual conference in 1959, conference papers carried over for publication in 1960 increased that category significantly. During the year, a new feature of the text called "Notes & Comment" was introduced to permit the publication of informal comment and discussion found to be of value but not suitable for handling as formal articles.

b. Cost and income. The smaller size of the 1960 JOURNAL helped to keep its cost below the budgeted amount despite increases in both printing and paper rates. Meanwhile, the drop of 90 pages in advertising resulted in an even larger reduction of income below that budgeted. The 25 per cent increase in advertising rates that became effective in March 1960, however, helped push advertising income above the 1959 record despite page losses. Because this increase affected only a very small percentage of the advertisers during the year, it is not believed that it was significantly responsible for the loss in pages. Rather, business uncertainty is felt to have been the major cause.

The reports of cost and income given in Tables 1 and 2 do not, of course, include the costs of salaries or overhead or the income from subscriptions.

TABLE 1

Journal Contents, Costs, and Income, 1956–60

Item	1956	1957	1958	1959	1960
CONTENTS:					
Text pages	1,618	1,646	1,682	1,620	1,648
P&R pages	1,262	1,426	1,390	1,388	1,264
Total pages	2,880	3,072	3,072	3,008	2,912
Text articles:					
Conference papers	54	28	41	24	49
Section papers	60	83	92	64	45
Contributions	50	33	46	68	62
Reports & official documents	15	17	25	15	23
Total articles	179	161	204	171	179
Abstract pages	55	100	99	112	120
COSTS:*					
Production	$ 8,144	$ 7,505	$ 7,623	$ 7,079	$ 7,848
Printing	55,266	64,238	65,991	73,537	75,604
Paper	19,033	23,284	25,030	25,154	25,875
	$82,443	$95,027	$98,644	$105,770	$109,327
Total cost index†	125.2	143.9	149.4	160.1	165.5
Cost per copy	53.0¢	57.0¢	56.0¢	59.3¢	59.5¢
Cost per 1,000 pages	$ 2.17	$ 2.19	$ 2.15	$ 2.33	$ 2.41
Printing rate index†	102.5	108.7	109.9	122.5	123.3‡
Paper rate index†	110.1	118.2	120.4	122.2	125.7
INCOME:					
Advertising	$115,816	$124,889	$131,988	$138,122	$138,505*
Subscriptions	9,879	10,835	10,464	13,790	13,531
Total pages paid advertising	987	1,092	1,040	1,051	961
Advertising rate index†	117.7	117.7	129.4	129.4	129.4§
Rate per 1,000 circulation	$ 8.34	$ 7.94	$ 8.27	$ 8.33	$ 9.86
Circulation (avg paid per issue)	11,844	12,639	13,316	13,215	14,006
Circulation index†	115.6	123.4	130.1	129.0	136.6

* At variance with audit figures because of different basis.

† 1953 = 100.

‡ The rise over 1959 is due to an increase that went into effect in December 1959. In 1961 the printing rate index will be 132.5, representing an 8.2 per cent increase in the 1959–60 rate.

§ An increase of approximately 25 per cent in advertising rates, which would raise the index to 162.3, was authorized to go into effect during the year but will not be fully applicable until 1961.

These are considered inseparable from other Association cost and income.

c. The future. In 1961, expecting some increase in the advertising section and planning to maintain the 1,650-page text schedule, the staff is counting on a JOURNAL of approximately 3,000 pages.

With an 8.2 per cent increase in printing rates—applied first in December 1960—effective throughout the year, and with the expected growth of more than 1,000 in circulation, the staff has estimated costs at $117,000 for the year. And with last year's advertising increase becoming effective on all advertisers and all space for the first time, an advertising income of $150,000 is forecast, even if the number of pages sold does not increase very much. With the "Soaring 60's" looking more like the "Sagging 60's" in their opening year, it is a little difficult to estimate with any degree of confidence, but the $150,000 figure seems a conservative one.

2. The Directory

As will be noted from the data in Table 3, despite a growth of 500 in members listed and an increase of 11 in advertising pages, the 1960 membership list edition of the Directory was held to the same number of pages as that in 1958. Thus, the cost of the book was kept slightly below budget expectations. As advertising income, meanwhile, exceeded estimates by 17 per cent, the net cost of the book was reduced significantly, to 20.1 cents.

Inasmuch as this edition of the Directory costs the Association $3,000 or $4,000 every other year, and inasmuch as there is considerable question concerning its usefulness to most members, investigation of other means of production and distribution continues. Photographic means of reproduction combined with the punchcard system now being explored by the Association offers some possibilities, if a limited-distribution directory will satisfy member requirements. Before any action along this line is recommended, members will, of course, be polled.

In 1961, the Reference Edition of the Directory will again be published. The cost of this smaller edition is expected to total $10,000 with advertising income reaching $14,000, representing a net income per copy greater than the net cost of the 1960 edition.

TABLE 2

Relation of Journal Cost to Advertising Income, 1956–61

Year	Total Cost	Advertising Income	Dollar Spread	Percentage Spread
1956	$ 82,442	$115,816	$33,374	40.4
1957	95,034	124,889	29,855	31.5
1958	98,644	131,988	33,344	34.0
1959	105,770	138,122	32,352	30.6
1960	109,327	138,505	29,178	26.7
1961 *	117,000	150,000	33,000	28.2

* Budget figures.

3. Standards and Reprints

New editions of the two steel pipe standards (C201 and C202) were issued during the year. These were published in the JOURNAL and subsequently made available as separate documents.

Sales of standards during the year totaled $12,800, compared with $14,900 in 1959, reflecting primarily the fact that the new standards were not only fewer, but that they were issued later in the year. Meanwhile, reprint sales

stayed approximately the same at $8,500, compared with $8,300. Expenses for these items were $5,400 for standards and $7,000 for reprints.

4. Willing Water

As will be noted in Table 4, in 1960 a slightly larger *Willing Water* was produced at a cost lower than in 1959 and lower by $3,000 than estimated in the budget, the savings being effected by a change in the addressing and mailing procedure.

During the year, content followed fairly closely the pattern established in 1959, featuring Association news, the Advancement Program, public relations, safety, statistical coverage, and, on occasion, a story aimed at the problems of the small-city operator.

In 1961, the same number of pages is scheduled to be produced at even lower cost, as the savings of the new mailing procedure will be obtained for the full year. Also, some savings will result from using the blue-paper section only for the Advancement quarterly. Content during 1961 is expected to be basically the same, with at least four pages per issue being devoted to community relations matters. An effort will also be made to aim the content of the Advancement quarterly more directly at the municipal official and the lay commissioner, with the thought of establishing the quarterly as a separate publication that can be mailed to acquired lists of such officials.

TABLE 3

Comparative Data on Directory Membership List Editions, 1956–60

Item	1956	1958	1960
Members included	11,138	12,332	12,863
Total pages	272	320	320
Number of copies printed	15,047	16,200	16,173
Total cost	$11,190	$13,724	$14,965
Cost per 1,000 pages	$2.69	$2.61	$2.86
Cost per copy	74.4¢	84.7¢	92.5¢
Cost per member	$1.00	$1.11	$1.16
Total pages paid advertising	56	70	81
Advertising income	$6,557	$9,186	$11,717
Net cost per copy	30.8¢	28.0¢	20.1¢

TABLE 4

Willing Water *Costs*

Item	1960	1959
Paper	$2,762	$2,624
Printing	8,730	8,091
Production	1,038	849
Postage	283	218
Mailing charges	2,858	4,506
Envelopes	660*	1,118
Total	$16,331	$17,406
No. of pages	152	148
Cost per page	$107	$118
No. of copies printed	166,500	163,000
Cost per copy	9.8¢	10.7¢
Total pages printed	2,106,000	2,010,000
Cost per 1,000 pages	$7.75	$8.86

* Although envelopes were used only in January, February, and March, this figure represents total value of envelopes on hand at beginning of 1960.

5. Booklets and Public Relations Aids

Total sales of AWWA's public relations booklets during 1960 were a little over 360,000, lower than in 1959 primarily because of one or two large orders then, but continuing to show strong popularity despite the lack of special promotion (sales figures are shown in Table 5). Meanwhile, in the list of public relations aids, a new decal and a Willing Water ashtray pushed sales to a new high.

a. The Story of Water Supply. Approaching the 2,000,000 mark in sales, *The Story of Water Supply* continues to attract a great deal of attention in the field of education. And this year's sales were helped, too, when a League of Women Voters group and a plumbers association auxiliary decided to

distribute a few thousand copies of the booklet in local schools as a "project."

In the new printing in August—the ninth—slight revisions were made in the water consumption figures, to bring the domestic use up from 50 to 60 gpcd and the total use from public systems from 140 to 150 gpcd. The continuing "discovery" of the booklet by new groups promises to keep it popular and profitable for some time to come.

The sound slide-film version of *The Story of Water Supply* has not yet caught on, only 10 copies being sold during 1960, bringing total sales since its introduction in 1958 to 87. Efforts to promote its use will be continued in 1961.

b. Your Water Supply. Again without special promotion, *Your Water Supply* made a new sales record in 1960, although barely exceeding the 1959 total. In 1961, this booklet will be given a critical review to see if it needs to be brought up to date.

c. What Price Water? Still a slow seller, *What Price Water?* in 1960 nevertheless approached the 100,000 total-sales mark. A new order at the end of the year pushed it over this total and indicated the booklet's continuing usefulness for special promotions.

d. Other public relations aids. During the year a new Willing Water design was developed and, using it, a new decal for automotive equipment and a new ashtray for waiting room and office use were prepared and offered for sale. The reception was enthusiastic, with 4,500 decals being sold from the time of their introduction in May and 654 ashtrays being sold during the month of December. Other items in this category, such as newspaper mats and electrotypes of the Willing Water cartoon, posters, postal meter ads, and novelty jewelry, were also most popular during the year.

In 1961, a second decal, in a smaller size, will be offered, and a number of other promotional items are being considered. Meanwhile, a new catalog of the aids has been prepared and will be published as part of an issue of *Willing Water* sometime in the spring. That should considerably increase sales of all items during the year.

6. Books

The major book event of 1960, of course, was the appearance of the eleventh edition of *Standard Methods,* but there were promising signs, too, that new editions of two other books were also getting under way. The lack of special promotion of books in 1960 showed its effects in reduced sales. In 1961, further promotion will be undertaken and a direct-mail offering to new members will be made in an effort to smooth out the biennial dips and peaks. Cumulative sales data on the five books published by the Association are included in Table 6, annual sales data being given in the review that follows.

a. Manual of Water Works Accounting (1938). Sales: the last 41 copies. A new chairman of the AWWA revision committee, Ralph L. Swingley, has now been appointed, and the committee to work with the Municipal Finance Officers Association group is now in process of formation. It is hoped that actual work on the new edition will get under way during 1961.

b. Survival and Retirement Experience With Water Works Facilities (1946). Sales: 34 copies in 1960; 126 in 1959; 30 in 1958; 105 in 1957.

c. The Quest for Pure Water (1948). Sales: 50 copies in 1960; 111 in 1959; 53 in 1958; 97 in 1957.

d. Water Quality and Treatment (2nd ed., 1950). Sales: 562 copies in

1960; 614 in 1959; 430 in 1958; 482 in 1957.

Organization of the revision committee for the third edition, delayed temporarily by consideration of the possibility of employing a writer to undertake the job, is now under way. The revision will be handled by a committee with the assistance of a staff member; it is expected that actual work on the book will be undertaken by the middle of the year.

e. Index to Journal AWWA (1940–55). Sales: 56 copies in 1960; 318 in 1959; 102 in 1958; 664 in 1957.

The possibility of preparing a 5-year supplement to this Index during 1961 is being considered, if staff time is available. At present the personnel situation is such that a budget for the project has not been requested.

f. Standard Methods for the Examination of Water and Wastewater. Sales of 500 copies of the tenth edition during 1960 brought total distribution of this edition in less than 6 years up to approximately 21,500, compared with the 22,000 copies of the ninth edition sold in its 9 years.

TABLE 5

Booklet Sales

Booklet	Number of Copies Sold		
	1960	1959	Total to Date
Story of Water Supply	220,500	332,800	1,849,000
Your Water Supply	131,300	129,500	1,181,200
What Price Water?	9,300	12,300	98,800

In October the eleventh edition, a volume of 658 pages, representing a major expansion of the text and a major revision of the water chemistry section, appeared, and its immediate acceptance was indicated by the 3,200 copies sold in the last 2½ months of the year.

The Joint Editorial Board of APHA, WPCF, and AWWA, under whose guidance the book was produced, will have a final meeting in March 1961 to review comments on the eleventh edition and make any corrections necessary in the second printing. The Joint Editorial Board for the twelfth edition will then be organized and begin work. Michael J. Taras, AWWA's representative, who

TABLE 6

Summary Data on Current AWWA Books and Manuals

Book	No. Printed	No. Bound	No. Sold
Survival and Retirement	3,006	2,509	2,407
Quest for Pure Water	2,632	2,632	2,035
Water Quality and Treatment (2nd Edition)	9,059	7,609	6,810
1940–55 Index	3,500	1,500	1,143
Manual			
Water Rates (M1)	3,700	3,700	2,922
Silent Service (M2)	5,038	2,538	1,667
Safety Practice (M3)	5,500	5,500	4,108
Management (M5)	3,083	3,083	2,069
Meters (M6)	4,539	4,539	3,132

made such a tremendous contribution to the eleventh edition, has consented to carry on as a member of the board for the twelfth edition.

7. Manuals

As a result of a policy problem on the approval procedure required of manuals, no new manuals were issued during 1960. Work on the Animal Identification Manual, however, was completed, and the material was published as an article in the December 1960 JOURNAL. Sales of the five manuals previously in print continued stronger than ever. (Annual sales data on the manuals are reported below; cumulative sales are given in Table 6.)

a. Water Rates Manual. Sales: 687 copies in 1960; 501 in 1959; 203 in 1958; 476 in 1957.

b. Silent Service Is Not Enough! Sales: 707 copies in 1960; 273 in 1959; 73 in 1958; 259 in 1957.

c. Safety Practice Manual. Sales: 875 copies in 1960; 648 in 1959; 857 in 1958; 738 in 1957.

d. Management Manual. Sales: 1,016 copies in 1960; 1,053 in 1959.

Promotion of this manual in 1961 will be geared to its use as a text for management courses developed by the AWWA Education Committee. It is thus expected that sales will grow so that a new printing will be required during the year.

e. Meter Manual. Sales: 1,477 copies in 1960; 1,205 in 1959.

f. Other manuals. As noted above, work on the Animal Identification Manual has been completed, and the document will be issued shortly.

Of the three remaining in-service training manuals scheduled, the distribution manual is completely edited and will be serialized in the JOURNAL beginning with the April 1961 issue [see p. 458]. The manuals on treatment and source are also awaiting JOURNAL space and staff time.

Meanwhile, the committee report on steel pipe installation and design has finally been cleared for publication. The committee's editor is now reviewing revised copy and proofs for some of the chapters affected by the new steel pipe standards which were issued in 1960, but serialization of the report is expected to start with the June issue of the JOURNAL. As most of the document is already in type, installments should appear fairly regularly after that until the 200-page report, plus any contributed discussion, is completed.

Submitted for publication at the end of 1960, too, was a final manuscript on the report of Committee 8320 D on installation of reinforced concrete pipe. This, too, is scheduled for publication during 1961.

8. Publication Sales

On Jan. 1, 1960, a new publication sales procedure involving the use of member discount coupons and the application of a handling charge to all small noncash, noncoupon orders was instituted. Although introduction of the system was attended by some confusion and although it has been necessary to bridge the change by accepting some orders on the old basis, the procedure has been most successful in speeding up the handling of orders and in cutting down the work load of billing small orders. During the year, 263 of the $10 coupon books were sold, and of the $2,630 in coupons represented, $1,666 has been applied to purchases. By use of the coupons, many members have earned discounts on publications not formerly subject to the 20 per cent savings.

A final stage in putting the sale of small publications on a reasonable basis will be the establishment of a minimum price. Investigation of the personnel time involved in the preparation, handling, and sale so far points to the desirability of a 50-cent minimum. A recommendation on this subject will be made when the study has been completed.

Reprints Available

Reprints of the following articles, published in the JOURNAL during recent months, will be available from the Association in small quantities, at the prices noted, until the present stock is exhausted. Order by reprint number and author's name from: Order Dept., American Water Works Assn., Inc., 2 Park Avenue, New York 16, N.Y. A handling charge of $1 will be added on all orders under $5 unless accompanied by payment in US or Canadian funds or in AWWA Publication Discount Coupons.

Reprint No.	Author	Title	Issue of JOURNAL	No. of Pages	Price per Copy
R914	COMMITTEE REPORT	Compensation of Water Utility Managers	Dec 59	30	45¢
R915	PANEL DISCUSSION	Demand Meters	Dec 59	18	30¢
R1001	SOPP	Price of Accidents	Jan 60	11	25¢
R1002	COMMITTEE REPORTS	Chlorine and Alum Supplies	Jan 60	12	25¢
R1003	SCHMID & BAUHAHN	Thrust Blocks	Jan 60	7	20¢
R1004	HOWSON	Revenue, Rates, and Planning	Feb 60	9	25¢
R1005	JACKSON	Tank Painting Practice	Feb 60	8	20¢
R1006	TASK GROUP REPORT	Status of Fluoridation, 1958	Mar 60	7	20¢
R1007	KOENIG	Well Stimulation Survey	Mar 60	18	30¢
R1008	CARL	Fire Protection Surveys as Indicators of Water System Status	Apr 60	8	20¢
R1009	PANEL DISCUSSION	Desalinization Processes	May 60	32	45¢
R1010	KOENIG	Well Stimulation Economics	May 60	7	20¢
R1011	EDITORIAL STATEMENT	Style Manual for Journal Authors	May 60	16	25¢
R1012	STUART	Main Extension Policies	Jul 60	8	20¢
R1013	PANEL DISCUSSION	Main Breaks	Aug 60	18	30¢
R1014	BAXTER	Rate-Making Principles	Oct 60	14	25¢
R1015	SWEITZER	Plastic Pipe	Oct 60	12	25¢
R1016	WOODWARD	Pesticides in Water	Nov 60	6	20¢
R1017	PANEL DISCUSSION	Ground Water Recharge	Dec 60	12	25¢
R1018	KOENIG	Well Stimulation Effects	Dec 60	16	25¢
R1019	TASK GROUP REPORT	Status of Fluoridation, 1959	Dec 60	8	20¢

Report of the Audit of Association Funds

For the Year Ending December 31, 1960

To the Members of the American Water Works Association:

The By-Laws require that the Secretary have an audit made annually of the books of the Association.

The records for 1960 have been examined by the staff of Louis D. Blum & Co. The complete record of that examination follows.

Audits have been published in the JOURNAL annually since 1937. They have appeared either in the March or April issue.

Respectfully submitted,
RAYMOND J. FAUST
Executive Secretary

January 30, 1961

TO THE AMERICAN WATER WORKS ASSOCIATION:

We have examined the balance sheet of the American Water Works Association as of December 31, 1960, and the related statements of income and surplus for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet as of December 31, 1960, and the related statements of income and surplus present fairly the financial position of the American Water Works Association at that date and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(Signed)

LOUIS D. BLUM & CO.
Certified Public Accountants

EXHIBIT A—Balance Sheet

December 31, 1960

Assets

Cash in Banks and on Hand		$133,175.10
Accounts Receivable:		
Advertising—Journal	$6,477.83	
Publications, reprints, and standards	1,266.90	
Other	461.97	8,206.70
Accrued Interest on Bonds		1,267.54
Inventories:		
Paper stock	6,815.49	
Type metal	3,642.26	
Books	4,754.46	
Manuals	2,634.12	
Booklets	4,918.65	
Standards	3,283.69	
Public relations material	600.97	
Back Issues—Journal—Vol. 1–52, inclusive (48,620 copies)	—*	
Back Issues—Proceedings—1881–1913, inclusive (245 copies)	—*	26,649.64
Office Equipment (less depreciation)		21,910.40
Investments at Cost (Schedule 1)		116,092.50
Deferred Expenses		4,133.59
Deposits—Airlines and Postage		925.00
Total Assets		$312,360.47

Liabilities and Surplus

Accounts Payable	$ 1,834.83
Membership Dues—Advance Payments	101,811.55
Unearned Subscriptions to Journal	6,798.32
Advances on Publications	5,777.28
Unearned Advertising	2,753.17
Senior Members Contributory Fund	6,718.11
Miscellaneous	166.10
Surplus, per Exhibit C	186,501.11
Total Liabilities and Surplus	$312,360.47

* No money values are assigned to back issues of Journals and Proceedings inasmuch as the entire costs were charged off during the year of publication.

EXHIBIT A, SCHEDULE 1—INVESTMENTS, DECEMBER 31, 1960

Description	Interest Rate %	Principal Amount	Cost	Quoted Market or Redemption Value Dec. 31, 1960
Foreign Securities:				
Province of Ontario	4	$ 1,000.00	$ 732.50	$ 965.00*
Hydro Electric Power Commission of Ontario	2.75	5,000.00	5,075.00	4,400.00†
Province of Ontario	3	2,000.00	2,022.50	1,827.50†
Hydro Electric Power Commission of Ontario	3	2,000.00	2,020.00	1,825.00†
Government of Canada	3	5,000.00	4,775.00	4,600.00†
United States Securities:				
US Savings Bonds, Series:				
G	2.5	2,500.00	2,500.00	2,447.50‡
G	2.5	1,000.00	1,000.00	976.00‡
K	2.76	5,000.00	5,000.00	4,860.00‡
K	2.76	2,000.00	2,000.00	1,938.00‡
K	2.76	25,000.00	25,000.00	24,200.00‡
K	2.76	10,000.00	10,000.00	9,680.00‡
K	2.76	10,000.00	10,000.00	9,670.00‡
US Treasury Bond	4.00	10,000.00	10,000.00	10,266.00
US Treasury Bonds	4.00	5,000.00	4,925.00	5,133.00
US Treasury Notes	4.75	8,000.00	8,000.00	8,334.40
Public Utility Bonds:				
Consumers Power Co.	4.75	5,000.00	5,431.25	5,112.50
Pacific Gas and Electric Co.	4.50	5,000.00	5,362.50	4,950.00
American Telephone and Telegraph Co.	5.00	5,000.00	5,406.25	5,262.50
Commonwealth Edison Co.	4.25	7,000.00	6,842.50	7,008.75
Totals		$115,500.00	$116,092.50	$113,456.15§

* Payable in United States funds.
† Payable in Canadian funds; market value represents value in New York in United States funds.
‡ These amounts represent redemption values on Dec. 31, 1960.
§ In addition to the securities listed above, the Association owns 1 share of Seymour Water Co. 6 per cent preferred stock, par value $25, received as a contribution in a prior year. The Association owns also 8 shares of Wallace & Tiernan, Inc., common stock $1 par value, with a market value of $27.75 per share at Dec. 31, 1960, contributed by the Treasurer of the Association.

EXHIBIT B—STATEMENT OF INCOME AND EXPENSES

FOR THE YEAR ENDED DECEMBER 31, 1960

Operating Income:		
Annual dues	$216,861.35	
Advertising—Journal and Directory	149,777.33	
Subscriptions to Journal	13,468.44	
Convention:		
Registration fees	55,437.00	
Ticket sales	759.50	
Other events	7.50	
Water and Sewage Works Manufacturers Assn.	7,500.00	
Interest and dividends on investments	5,077.12	
Miscellaneous income	265.77	
TOTAL OPERATING INCOME (carried forward)		$449,154.01

TOTAL OPERATING INCOME (brought forward)			$449,154.01
Publications Income:			
Books		3,099.64	
One-third of profit from sales of Standard Methods (book)		4,701.44	
Manuals		8,403.12	
Booklets		11,979.89	
Standards		12,403.22	
Journals (back issues)		1,425.47	
Public relations material		5,475.07	
Reprints		9,006.97	
Miscellaneous		369.68	
TOTAL PUBLICATIONS INCOME			56,864.50
TOTAL INCOME			$506,018.51
Operating Expenses:			
Directors and Executive Committee Meetings:			
Travel expense		12,774.65	
Administrative Expenses:			
Rent	$13,500.00		
Office supplies and services	21,846.25		
Membership promotion	961.15		
Pensions—Secretaries Emeritus	6,820.11		
Contributions to Pension System	11,569.47		
Legal and auditing expenses	1,427.06		
General and special travel	4,987.54		
Federal activities	1.65		
Mailing list service	1,761.82		
Social security taxes	2,310.10		
Hospitalization insurance	960.61	66,145.76	
Administrative Salaries		122,861.57	
Committee Expense		1,369.15	
Division and Section Expenses:			
Section—membership allotment	$31,219.37		
Section—travel expense	6,426.91		
Section—Advancement travel expense	2,050.65		
Section—general expense	562.20	40,259.13	
Journal:			
Printing	75,590.89		
Production	9,077.90		
Paper	25,875.25		
Directory	14,138.22	124,682.26	
Convention		40,027.18	
Membership Dues in Other Associations		4,588.75	
Depreciation of Office Equipment		3,301.74	
Miscellaneous		3,433.85	
TOTAL OPERATING EXPENSES (carried forward)		$419,444.04	

TOTAL INCOME (brought forward)			$506,018.51
TOTAL OPERATING EXPENSES (brought forward)		$419,444.04	
Cost of Publications Sold:			
Books	$ 1,625.33		
Standard Methods (book)	1,209.00		
Manuals	2,495.49		
Booklets	7,256.74		
Standards	3,901.87		
Journals (back issues)	7.90		
Public relations material	5,188.80		
Reprints	7,015.21		
Miscellaneous	3,351.46	32,051.80	
Development Activities:			
Public relations	16,478.25		
General publicity	2,855.00		
Safety awards	117.43	19,450.68	
TOTAL EXPENSES			470,946.52
Net Income for the Year (transferred to Exhibit C)			$ 35,071.99

STATEMENT OF SURPLUS FOR THE YEAR ENDED DECEMBER 31, 1960

Balance, January 1, 1960	$151,429.12
Add: Net income for the year, per Exhibit B	35,071.99
Balance, December 31, 1960, per Exhibit A	$186,501.11

American Water Works Association Pension System

BALANCE SHEET—DECEMBER 31, 1960

Assets

Cash in banks	$ 8,095.04
Accrued bond interest	1,422.81
Due from American Water Works Association	211.51
Investments (Schedule 1)	156,339.58
TOTAL ASSETS	$166,068.94

Liabilities and Reserve for Future Benefits

Liability for refund of employees' contributions plus earned interest	$ 20,180.74
Reserve for future benefits	145,888.20
TOTAL LIABILITIES AND RESERVE	$166,068.94

STATEMENT OF RECEIPTS AND DISBURSEMENTS FOR THE YEAR 1960

Item	Cash	Reserve for Future Benefits	Liability for Refund of Employees' Contributions	Due From AWWA
Receipts:				
Association contributions	$11,357.96	$ 11,569.47*	$ —	$ —
Employees' contributions	$ 3,129.54		3,129.54	
Interest on bonds	4,571.15	4,571.15		
Interest on savings-bank account	33.48	33.48		
Total	19,092.13	16,174.10	3,129.54	
Disbursements:				
Refund of contributions plus interest	1,312.60		1,312.60	
Audit expense	50.00	50.00		
Office expenses	98.00	98.00		
Investment in securities	12,484.38			
Pension—Paid	5,679.89	5,679.89		
Total	19,624.87	5,827.89	1,312.60	
Excess of Cash Receipts Over Disbursements	(532.74)†	10,346.21	1,816.94	
Adjustments for Non-Cash Items:				
Interest credited to employees' accounts		(572.57)†	572.57	
Interest accrued on bonds, Jan. 1, 1960		(1,179.58)†‡		
Interest accrued on bonds, Dec. 31, 1960		1,422.81§		
Cash in transit				(211.51)†
		(329.34)†	572.57	(211.51)†
Additions to accounts for year	(532.74)†	10,016.87	2,389.51	
Balance, Jan. 1, 1960	8,627.78	135,871.33	17,791.23	
Balance, Dec. 31, 1960	$ 8,095.04	$145,888.20	$20,180.74	$(211.51)†

* Includes cash in transit of $211.51 shown below.
† Indicates red figures.
‡ Accrued interest receivable as per balance sheet Dec. 31, 1959.
§ Accrued interest receivable as per balance sheet Dec. 31, 1960.

SCHEDULE 1—INVESTMENTS, DECEMBER 31, 1960

Description	Interest Rate %	Cost	Quoted Market or Redemption Value, Dec. 31, 1960	Maturity Date
Bonds Registered in Name of Administrative Committee:				
United States Securities:				
US Savings Bonds:				
Series G	2.5	$ 10,000.00	$113,362.20	1961
Series G	2.5	10,000.00		1962
Series G	2.5	14,000.00		1963
Series K	2.76	9,000.00		1964
Series K	2.76	17,000.00		1965
Series K	2.76	9,000.00		1966
Series K	2.76	9,000.00		1967
Series K	2.76	20,000.00		1968
US Treasury Note	5.00	10,000.00		1964
US Treasury Note	5.00	5,046.88 *		1964
US Treasury Bonds	4.00	1,970.00		1969
Utility Bonds:				
Detroit Edison Co.	3.00	4,565.00	40,159.38	1970
Brooklyn Union Gas Co.	2.875	4,089.90		1976
Consolidated Edison Co.	2.75	4,200.00		1982
New England Telephone & Telegraph Co.	3.00	4,030.92		1982
American Telephone & Telegraph Co.	5.00	6,480.00		1983
Consumers Power Co.	4.75	4,315.00		1987
Commonwealth Edison Co.	4.25	977.50		1987
Pacific Gas & Electric Co.	4.50	5,226.88		1990
Duke Power Co.	5.125	7,437.50 *		1990
Totals		$156,339.58	$153,521.58	

* Acquired in 1960.

1960 Section Membership Awards

Old Oaken Bucket		Hill Cup		Henshaw Cup	
Section	Score*	Section	Score†	Section	Score‡
California	1,678	Wisconsin	76.224	Rocky Mountain	75.6
Southwest	1,091	Florida	33.592	Pacific Northwest	71.9
New York	907	North Central	24.256	Montana	71.4
Canadian	753	Nebraska	23.551	South Dakota	68.1
Illinois	686	Southwest	23.205	Alabama-Mississippi	63.9
Pennsylvania	572	Rocky Mountain	11.682	Kentucky-Tennessee	61.1
New Jersey	548	New Jersey	10.738	Ohio	59.3
Michigan	507	Iowa	8.148	Iowa	54.4
Indiana	489	Virginia	6.728	California	51.7
Ohio	487	Arizona	6.300	Illinois	46.2
Pacific Northwest	464	New England	6.289	West Virginia	45.4
Florida	412	West Virginia	6.196	Wisconsin	44.9
Wisconsin	316	Pennsylvania	5.904	Intermountain	44.7
Chesapeake	307	Canadian	5.270	Indiana	43.9
Southeastern	307	Chesapeake	4.720	North Central	42.7
North Central	256	North Carolina	4.230	Michigan	41.3
Alabama-Mississippi	243	Montana	2.664	Chesapeake	39.0
Kentucky-Tennessee	236	Alabama-Mississippi	2.412	Kansas	36.7
Missouri	235	Pacific Northwest	2.192	Virginia	36.3
Kansas	234	Southeastern	2.139	Florida	33.8
Iowa	214	California	1.645	New Jersey	33.7
Virginia	214	Ohio	1.107	Southwest	31.0
Rocky Mountain	205	New York	0.696	Connecticut	28.4
North Carolina	195	Michigan	0.446	Pennsylvania	27.6
New England	186	Cuban	§	Arizona	#
West Virginia	118	Illinois	§	Canadian	#
Nebraska	112	Indiana	§	Cuban	#
Arizona	107	Intermountain	§	Missouri	#
Intermountain	107	Kansas	§	Nebraska	#
Connecticut	105	Kentucky-Tennessee	§	New England	#
Montana	62	Missouri	§	New York	#
South Dakota	48	Connecticut	‖	North Carolina	#
Cuban	27	South Dakota	‖	Southeastern	#

* Numbers of members.
† Weighted gain in membership.
‡ Percentage of members present at annual meeting.
§ Minus score.
‖ Ineligible during 1960.
\# Data not available or section not competing.

AWWA Membership Growth

Membership Statement—Year of 1960

Grade	Dec. 31, 1959	Net Change in 1960	Dec. 31, 1960
Active	10,270	400	10,670
Corporate & Municipal Service Subscriber	1,265	−20	1,245
Associate	320	−7	313
Life & Honorary	451	44	495
Junior	65	−35	30
TOTAL	12,371	382	12,753

Gains and Losses—25-Year Period

Year	Gain	Loss	Net	Total Members at End of Year
1936	364	222	42	2,724
1937	601	261	340	3,064
1938	579	284	295	3,359
1939	642	301	351	3,710
1940	572	325	247	3,957

Gains and Losses (contd.)

Year	Gain	Loss	Net	Total Members at End of Year
1941	572	352	220	4,177
1942	629	365	264	4,441
1943	857	328	529	4,970
1944	826	311	515	5,485
1945	599	346	253	5,738
1946	895	492	403	6,141
1947	1,007	492	515	6,656
1948	928	554	374	7,030
1949	1,158	519	639	7,669
1950	950	549	361	8,070
1951	1,153	640	513	8,583
1952	1,071	737	334	8,917
1953	1,176	633	543	9,460
1954	1,229	749	480	9,940
1955	1,334	848	486	10,426
1956	1,542	895	647	11,073
1957	1,521	942	579	11,652
1958	1,515	900	615	12,267
1959	1,430	1,326	104	12,371
1960	1,538	1,156	382	12,753

Notes and Comment

Corrections to Eleventh Edition of *Standard Methods*

The following changes will be incorporated in the second printing of the eleventh edition of *Standard Methods for the Examination of Water and Wastewater*. The attention of all purchasers of the first printing is called to these changes so that they can make appropriate corrections or additions in their copies.

1. Page ix. In the right column of the WPCF Committee list, "R. Pomery" should read "R. D. Pomeroy."

2. Page xiii. The first entry under "Phenols" should read: "Preliminary Distillation Procedure."

3. Page 11. In the left column, the second paragraph from the bottom should be amended to read: "If there is a significant reagent blank, but no color or turbidity in the sample, the necessary correction can be made by adding the color-developing reagents to distilled water and nulling the photometer with the resulting solution."

4. Page 12. In the left column, fifth line from the top, "a zero blank standard" should be replaced with "distilled water."

5. Page 12. In the left column, seventh line from the bottom, "filtering procedure" should be changed to "flocculating or filtering procedure."

6. Page 66. In the second line in Section 4.1, "100 mg" should read "50 mg."

7. Page 108. In the second line of Section 3.2, "1,5-diphenylcarbazide" should read "1,5-diphenylcarbohydrazide." (When a numerical prefix is attached, "diphenylcarbazide" should properly be "diphenylcarbohydrazide"; this chemical may also be referred to as "*s*-diphenylcarbazide.")

8. Page 147. The second paragraph under "Lead" should be amended to read: "The method outlined below for the determination of lead is applicable to potable waters. An additional colorimetric method for lead in sewage and industrial wastewater is described in Part III, Metals (Heavy), Method F (Lead)."

9. Page 161. In the right column, eighth and fourth lines from the bottom, "meter" should be changed to "needle."

10. Page 171. The last sentence in Section 4.4 should be amended to read: "Lower the collected distillate free of contact with the delivery tube, and continue distillation during the last minute or two to cleanse the condenser."

11. Page 174. In the second and third lines of Section 2.2, "or KOH" should be deleted.

12. Page 174. In the third line of Section 2.3*b*, "$KNa_4H_4O_6$" should read "$KNaC_4H_4O_6$."

13. Page 184. The last sentence in Section 4.3 should be amended to read: "Lower the collected distillate free of contact with the delivery tube, and continue distillation during the last minute or two to cleanse the condenser."

14. Page 197. The title "Preliminary Screening Procedures" should read "Preliminary Distillation Procedure."

15. Page 205. In the third line of Section 4.2, "10 and 50 ml." should read "25 and 50 ml."

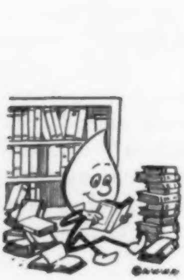
16. Page 284. In the seventh line of the second paragraph in Section 3.2, the figure "3.250" should be changed to "3.249."

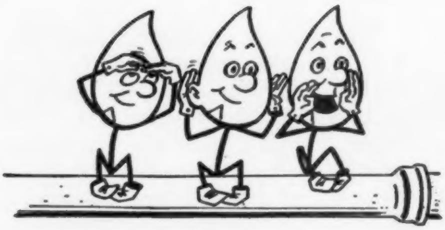
17. Page 368. In the second line of Section 3.12, "1,5-diphenylcarbazide" should read "1,5-diphenylcarbohydrazide." (See correction No. 7.)

18. Page 397. In the first line of Section 2.1, "140-ml" should read "125-ml." An asterisk (*) should be inserted at the end of this line, and the corresponding footnote should read: "* American Instrument Co., Cat. No. 5-226 or equal."

19. Page 397. In the fourth line of Section 2.2, the asterisk should be changed to a dagger (†); consequently, in the footnote at the bottom of the page, the asterisk should be changed to a dagger.

20. Page 503. In Table 30, third column from the right, the first line in the sixth group of five lines, "22" should be changed to "33."





Percolation and Runoff

Eau K, eau K has been the story of the past month, with, first, Senator Kerr, and, then, President Kennedy focusing the spotlight on water resources. And more than just OK, too. Both of them were really on the beam, eschewing predictions of imminent doom in favor of presenting positive programs for assuring the nation and the world all the water they need when and where they need it.

The text of the Kerr committee summary report is featured in the more permanent pages of this issue (p. 371), but having so long waited for appreciation of the problem by someone who is somebody in a position to do something, we cannot resist quoting here one happy paragraph that tells the story we have never had the voice to tell:

With its abundant supply of good water and its advanced technology and skills, the United States need never suffer for lack of water. Water shortages can be alleviated. The lack of water need not limit our economic destiny. But positive action must be substituted for complacency. There is work to be done, work to develop and use the abundant resources placed in our custody by a Munificent Providence, work to develop the practices and techniques which will permit ever increasing needs to be filled within the finite limits of the resources we have. *First and most important step toward getting the job done is the development of increased public awareness and understanding of the nation's water resources problems; of their effects on the nation's economy; and of the possible ways of solving them.*

President Kennedy, too, did some telling telling in outlining to Congress a natural resources program that gave some hope of a reduction, if not an end, of wasteful conflict among the welter of federal agencies responsible for the nation's resources, that put the desalinization program in better perspective in aiming it at the solution of world water problems, and that even suggested:

If all areas of the country are to enjoy a balanced growth, our federal reclamation and other water resource programs will have to give increased attention to municipal and industrial water and power supplies as well as irrigation and land redemption. . . .

Komes the millennium!

Baring their teeth, but few facts about them, were Mayors Stanley J. Davis of Grand Rapids, Mich., and W. B. Hartsfield of Atlanta, Ga., last

(*Continued on page 40 P&R*)

(Continued from page 39 P&R)

Feb. 18 in debating the question "Is Fluoridation of Public Drinking Water Desirable?" on NBC-TV's network feature, "Nation's Future." We don't know if the extra police employed to guard the studio during this show were busy or not, but it would have been helpful if one of them could have been detailed to direct the traffic in words. Whether or not anyone was able to elicit any telling pros or cons from the dispute, it is doubtful that either mayor convinced his opponent or anyone else of either the merits or evils of fluoridation. But, then, it is perhaps already too late to convince anyone anyway. Certainly current statistics on the progress of fluoridation would almost seem to support the fact that everyone has already made up his mind.

We did read recently that installation of water fluoridation equipment for Barneveld, Iowa County, Wis., was approved, but the more significant changes now seem to be awaiting the operations of the mortality table—personal or political. Being less aroused about the subject than most, we shall plan to wait.

John D. Johnson has retired as general superintendent of the Erie (Pa.) Bureau of Water, after 54 years of service with the agency. A member of AWWA since 1942, he was presented with the Fuller Award in 1954.

Charles Stewart Mott, president of the Northern Illinois Water Co., has presented stock valued at $545,187 to Stevens Institute of Technology, Hoboken, N.J. This gift brings his contributions to the college's endowment fund to more than $900,000.

The grease monkey is dead, long live the lubrication mechanic. So said the editors of *Mill & Factory* magazine in sizing up the 'Sixties in a recent issue. More than just semantics, though, their point was that the trend toward mechanization and automation in production facilities, toward the substitution of electronic, pneumatic, and hydraulic controls for human operators, has raised the maintenance department from the janitorial level to one where it requires the highest skills in today's industrial plant. Water utility operations may not generally have reached that point yet, but they are certainly headed in that direction. All of which emphasizes the importance of in-service training programs to make mechanics of your monkeys, lest your equipment make monkeys of your mechanics.

Domestic water system sales in 1960 were down more than 100,000 from the mark of 786,000 in 1959. Looking for a reason among the statistics of home building and population movements, we encountered this possibility in a Canadian newspaper:

> In the drinking well
> Which the plumber built her,
> Aunt Eliza fell . . .
> We must buy a filter.

One might suppose, though, that a simple aunt decanter would suffice.

Warren A. Gentner has retired as chief engineer and deputy manager of the water bureau of the Hartford (Conn.) Metropolitan District, after 48 years of service with the district. Appointed as deputy managers were Gilbert U. Gustafson and Alexander J. Minkus.

(Continued on page 42 P&R)

(*Continued from page 40 P&R*)

Winter complaint, of which we gave some intimation last month (March P&R, p. 44), seems now to have spread in all directions, with freezeups, main breaks, drought, and floods as the principal symptoms:

At Albion, N.Y., with its creek source frozen dry, the village had been tapping the Erie Barge Canal until it drew that down to a stagnant 3 ft. Action by Governor Rockefeller permitted lifting the locks under repair to replenish the auxiliary supply, but real relief was a good many swallows away.

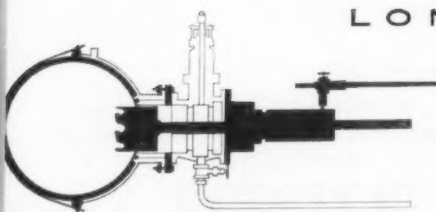
At Bath, N.Y., with the frost line down more than 5 ft, the water table was affected to the point of reducing yield from one of the city wells. Meanwhile, the utility's emergency crew was working full time with its thawing equipment to keep Bath water running.

At Belfast, N.Y., a combination of leaking mains and open taps to prevent freezeups drained the reservoir dry

Albert G. Fiedler (left), assistant chief of the water resources division, USGS, recently received the Distinguished Service Award of the Department of the Interior, presented by Assistant Secretary Royce A. Hardy. The award was presented for his 41-year career, distinguished by leadership and research in ground water hydrology and ground water law. He is a Life Member of AWWA, having joined in 1929. He was presented with the Goodell Prize in 1939 and the Fuller Award in 1958.

(*Continued on page 44 P&R*)

LONG-TERM ECONOMY



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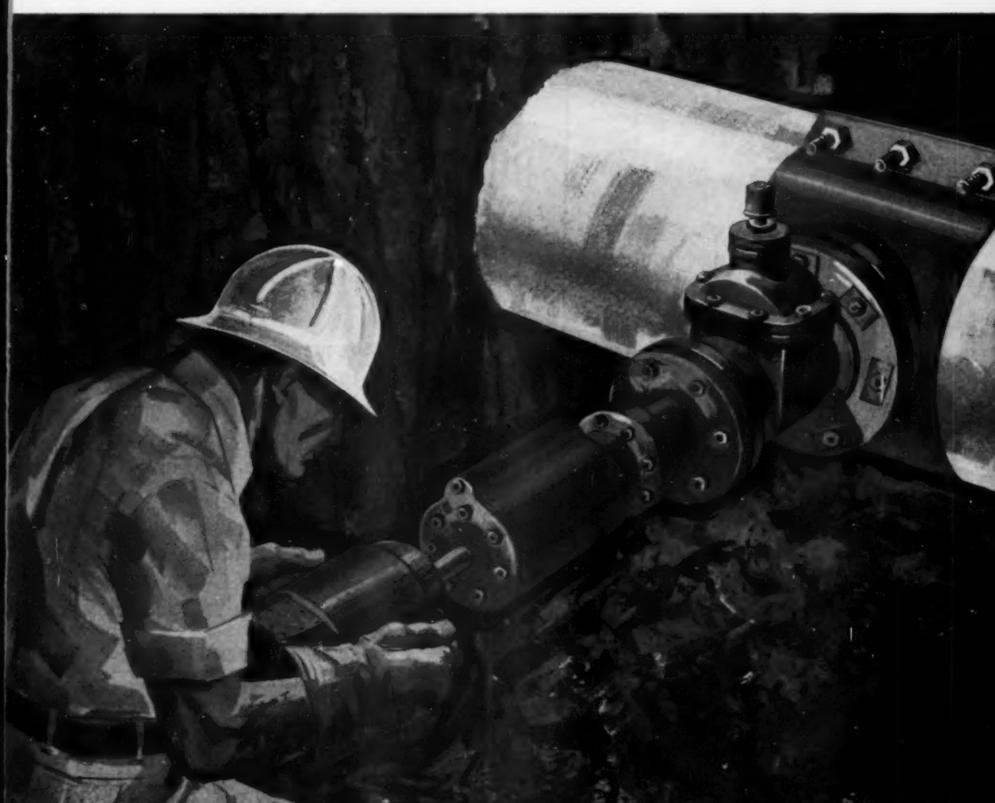


(Continued from page 42 P&R)

and sent authorities to the nearby Genesee River to draw an emergency supply through fire hoses.

At Cleveland, Ohio, a single break flooded a ten-block area to depths of 2 ft.

At Kansas City, Mo., ice jams along the Missouri were so bad they blocked the mouth of the Kansas River and reversed its flow.

At Louisville, Ky., main breaks increased sharply and ice-breaking crews had to be put to work to keep the coagulation basins operating.

At Milwaukee, Wis., a main break flooded a steam heat channel serving 567 buildings in the business district and disrupted or discontinued operations throughout the area as the heat was cut down and, finally, out when the steam line broke, too.

At Oakhurst, N.J., a frozen water main to a grammar school gave 1,000 pupils an extra holiday and their mothers extra work.

At Ogden, Utah, the snowlessness of surrounding mountains threatened the shortest water supply in the 40 years that surveys have been made.

At Ottosen, Iowa, frozen ground concealed a leak that boosted pumpage from the normal 3,000 to 13,000 gpd and necessitated shutdown of the softening plant, which couldn't handle the load. At the end of 2 weeks of hunting, with the leak traced only to "the south part of town," authorities were ready to employ a dowser.

At Passaic, N.J., the Passaic Valley Flood Control Assn. issued a warning to all communities in the valley that the ice volumes on the river were so

(Continued on page 46 P&R)

(*Continued from page 44 P&R*)

great that they faced the worst flooding in the area's history when the thaws set in.

At St. Louis, Mo., a break in a 48-in. main during 20°F weather turned the surrounding streets into frigid rivers, turned over cars, flooded homes and business establishments, sent firemen and Coast Guardsmen on rescue missions in boats, and did an estimated $500,000 in damage.

At Sylvan Beach, N.Y., residents were melting snow in their bathtubs to obtain water as 75 of the community's 370 services were frozen solid and the supply to the others was dwindling fast.

At Trenton, N.J., state officials were working with the Army and Coast Guard on plans to avert disaster if a sudden thaw set in, record snow on the watersheds and record ice in the rivers threatening worse conditions than during the New Jersey–Pennsylvania floods of 1955.

And at West Keansburg, N.J., the local water company was distributing 2 gpd per customer by hand to those in the frozen service area.

Remember the winter of 1960–61?

'Computer Forecast Kennedy Sunshine' was the headline in the London *Observer* on Feb. 5, crediting Dr. Irving P. Krick, Water Resources Development Corp., Denver, Colo., with another triumph in weather forecasting. The forecast, made on Dec. 16, read:

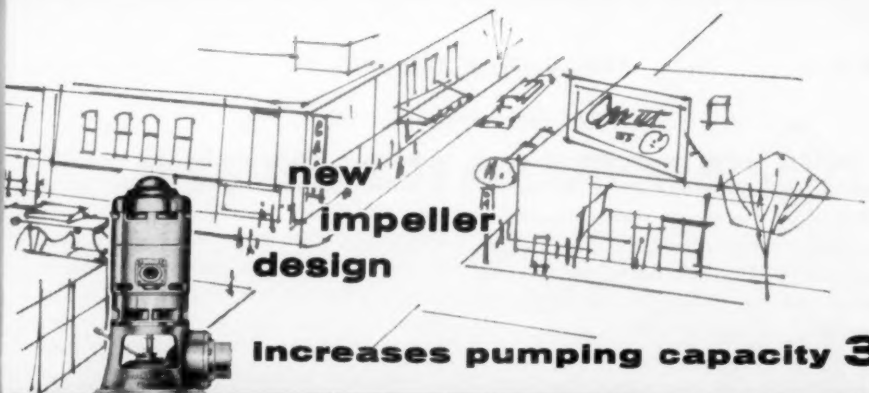
> Our forecast for Washington, D.C., on Friday, Jan. 20, calls for fair weather with no precipitation. However, it will be cold. Snow may accompany a storm a few days prior to Jan. 20, but there should be time to clear the streets following it. Another period of stormy weather will arrive in Washington late Jan. 21 or 22.

Well, as the *Observer* said, he was right, but not dead right. Still we admire the guy for his willingness to risk being right dead for, as the inaugural committee said, "a sense of civic duty."

All this, though, harks back to a once favorite subject of Irving Krick's and ours—the subject of rainmaking, that is, still far from dead, though inclined now to be rather deadly in many places. Our files these days are rather meager, going back almost a year to a report from the University of California on a 3-year survey of silver iodide seeding that "left unanswered" the question of whether the technique was effective or not. Then, last August, we discovered a report in *Science Digest* concerning the seeding ability of salt spray and the dust of meteors [they had it]. And in December we learned that the Chinese Communists were playing with the silver iodide technique as developed in the United States and in the Soviet Union, reporting 70–80 (interpreted as 10–15) per cent success. Finally, last month from Australia we had word that US U-2 planes were helping an Australian scientist, "Taffy" Bowen, in a study of seeding procedures, while the Commonwealth Research Organization was reporting varying degrees of success with silver iodide, with precipitation gains reaching 25 per cent in one test region.

One would have to say that seeding isn't nearly as successful now as we were able to report it some years ago. It must be that clouds, like crops, need rotation in their seeding. Or more imagination. Or less classification. Or to start raining.

(*Continued on page 48 P&R*)



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For further information on Fairbanks-Morse new Deep-Well Turbine Pumps, write: **Pump & Hydraulic Division; Fairbanks, Morse & Co.; Kansas City, Kansas.**

FAIRBANKS MORSE

A MAJOR INDUSTRIAL COMPONENT OF

FAIRBANKS WHITNEY

(*Continued from page 46 P&R*)

Instant coffee having been one of our pet abominations, we were hardly thrilled by the recent announcement of instanter coffee—instant coffee, that is, premeasured in an instant pouch. No more arduous computation of quantity required, no more tedious washing of the spoon, just drop the pouch into a (paper) cup of hot water, the pouch dissolves with the coffee, and there you are—there *you* are, not us.

All this instantaneity, though, has set us thinking. Just add water these days and almost anything is yours—from pumpkin pie to paint, from coffee to concrete—so why not an instant wife? After all, a constituted woman is more than 70 per cent water. Dehydrated, a most acceptable one would total no more than 30 lb of chemicals—worth $2.50 in the good old days, but probably $7 now. No matter, we're a sport, and the 9 gal of water to be added will cost no more than half a cent. As a matter of fact, for $7.25, we can probably pay for a reconstituted wife and two cups of instanter coffee.

The directions, by the way: *pour little me.*

The biggest 1961 compact promises to be neither automotive nor cosmetic, but water resourceful—the Delaware River Basin Compact, that is, through which the governors of Delaware, New Jersey, New York, and Pennsylvania, together with a representative of the federal government, will become members of a commission for

(*Continued on page 50 P&R*)

This Month Years Ago

April 1911—At the Torresdale plant in Philadelphia, disinfection with chloride of lime was discontinued for the summer. It had been applied to the water in the clear-water basin after finding that the bactericidal efficiency of hypochlorite declined in cold weather.

. . .

April 1911—"A high-pressure water supply system for fire protection in Boston is strongly advised in a report just made public by the Committee on Fire Prevention of the National Board of Underwriters . . . the report states that 'high-pressure water mains used exclusively for fire protection' have already been installed in New York City (three systems altogether), Philadelphia, Cleveland, Detroit, Buffalo, Oakland, Cal., Toronto, Ont., and Winnipeg, Man. In addition, San Francisco and Baltimore are putting in such systems, and Portland, Ore., and Toledo, Ohio, have started them. The system in Philadelphia has been in use nearly eight years."

. . .

April 1886—J. Nelson Tubbs, superintendent of the water works of Rochester, N.Y., describes in his annual report the multiple-jet aerators provided in the distributing reservoir for use during the summer. "The water returns in finely divided particles, almost in the form of spray, and in its passage through the air is thoroughly aerated. The fountain . . . is . . . visible in some directions at a distance of at least 12 miles, and attracts a vast number of visitors during the season in which it is in operation."

(Continued from page 48 P&R)

the planning, conservation, utilization, development, management, and control of the water and related natural resources of the Delaware River Basin for the improvement of navigation, reduction of flood damage, regulation of water quality, control of pollution, development of water supply, hydroelectric energy, fish and wildlife habitat, and public recreational facilities, and other purposes . . .

on the 12,757-sq mi Delaware Basin. Unique in including the federal government as an equal partner with the states, in including the governors, themselves, rather than appointees, as members of the commission, and in the broadness of the powers involved, the proposed "treaty" is also unusual in specifically barring sale of hydroelectric power from Delaware River plants to ultimate consumers, reserving the power for utilities and other wholesale users.

Having received the blessing of all four governors and of the federal-government representatives who participated in developing it, the agreement now must receive the approval of Congress, where it has already been introduced in both houses, and the legislatures of the four states. Most impatient for approval are the Army Corps of Engineers, whose 58-project, $437,000,000 water storage plan will come under the compact, and New York City, whose rights to 800 mgd of Delaware water will be virtually secured by it.

The "biggest" perhaps will not seem to be justified when the service area involved is less than 1 per cent of the land area of the United States. But with 13 per cent of the nation's population residing there it certainly has to be acknowledged as "compact."

(Continued on page 54 P&R)

In Indiana (above)—"All-weather" cast iron pipe is quickly installed despite wet trench conditions. Slip-on joints were easily assembled, with one workman using a crowbar.

In Kansas (above)—36" cast iron water main. Another part of this main was floated out of its trench by a heavy downpour. Later a 150 psi water test revealed no leaks in the slip-on joints!

In Pennsylvania (below)—This 16" cast iron pipe is being installed as fast as the trench hoe can prepare the trench. Handy lengths and slip-on joints make cast iron pipe easy to handle, even in crowded neighborhood sectors; require less labor.

CAST IRON PIPE

THE MARK OF THE 100-YEAR PIPE

Cast Iron Pipe Research Association, Thos. F. Wolfe Managing Director, 3440 Prudential Plaza, Chicago 1, Ill.

(Continued from page 50 P&R)

Samuel B. Nelson

William S. Peterson has retired as general manager and chief engineer of the Los Angeles Dept. of Water & Power. His successor is Samuel B. Nelson, formerly chief engineer of water works and assistant manager, the position that has been taken over by Max K. Socha. In a reorganization of the department, Burton S. Grant has been assigned to a new position of assistant to the general manager.

What price water? is a question we keep asking, and the answers range from the ridiculous to the sublime. You are familiar with the ridiculous.

"At least sublime" said the residents of Virginia City, Nev., when the Nevada Public Service Commission last spring approved domestic rates of $6 for the first 300 cu ft, 60 cents per 100 for the next 700 cu ft, 50 cents per 100 for the next 1,000 cu ft, and 40 cents per 100 for all over 2,000 cu ft. Not the cost of lime, but the cost of getting water from Lake Marlette 30 miles through the mountains to Virginia City through a system that cost a million dollars when it was built back in the days of the Comstock Lode was the basis of the price.

"Not enough" said owners of property in the Isles of Capri subdivision in Everglades, Fla., when a developer proposed a rate of $6 for the first 2,000 gal and $2.50 each for each additional 1,000 gal, plus a meter charge of $15 and a connection charge of $25. Reason for the "not enough," of course, is that the property owners, who must also pay $650 for the privilege of access to water on tap, are worried that the "residents" will not be paying enough to cover the supplier's cost of bringing the water from Naples by tank truck, dumping it into a reservoir, and then pumping to the homes. And if they don't pay enough, obviously property values will go down.

"Cheap" said the followers of "Bishop" William Estep when he asked $1,000 for a year's supply of

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(Continued from page 54 P&R)

"Life Water" guaranteed to keep them alive a thousand years. And even cheaper was his "Thermal Water" for the cure of cancer, heart trouble, and almost any other serious disease, or "E Water" for the even quicker cure of the same diseases. Unfortunately, the "Bishop," or Dr. John Smith, as he also called himself, was deprived of the opportunity to prove his claims for the tap water that he treated with infrared lamps, multicolored filters, and radio tubes in his own kitchen, when investigators from the California Board of Medicine apprehended him and confronted him with FBI charges of bail jumping and parole violation as well as federal revenue agent's claims of tax evasion.

"Peanuts" said Hamed Ibn el Hatib, a wealthy merchant who was dying of thirst in the Sahara desert when he paid his camel driver $20,000 for the driver's last drink of water. Unfortunately for both of them, they both died 1,000 ft from an oasis, but the money, together with a signed statement of the transfer, was found on the driver and paid to his widow.

What price water, indeed?

The National Conference on Water Pollution, held last December, attracted a registration of more than 1,200 participants. Reports on results of the meeting indicate that it helped to develop new information and fresh points of view on the important subject of pollution control. Thirty recommendations by sub-committees are included in a conference report, which is available on request from USPHS.

(Continued on page 98 P&R)

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Key: In the reference to the publication in which the abstracted article appears, 39:473 (May '47) indicates volume 39, page 473, issue dated May 1947. If the publication is paged by the issue, 39:5:1 (May '47) indicates volume 39, number 5, page 1, issue dated May 1947. Abbreviations following an abstract indicate that it was taken, by permission, from one of the following periodicals: *BH—Bulletin of Hygiene (Great Britain); CA—Chemical Abstracts; Corr.—Corrosion; IM—Institute of Metals (Great Britain); NSA—Nuclear Science Abstracts; PHEA—Public Health Engineering Abstracts; SIW—Sewage and Industrial Wastes; WPA—Water Pollution Abstracts (Great Britain).*

BACTERIOLOGY

The Significance of the Differentiation of Coli and Coliform Bacilli for the Bacteriological Testing of Water. W. Kretzschmar. *Z. Ges. Hyg.* (Ger.), 5:73 ('59). In the course of bacteriologic studies of river water, it was found that the generally used methods for demonstration of *B. coli* gave incorrect results. A new, scientifically based method was worked out, which deviates from the earlier methods of separation of fecal and nonfecal coli. The conceptions of coli of warm-blooded and cold-blooded organisms are abandoned. For the genera *Arizona, Citrobacter Klebsiella,* and *Hafnia,* the collective name of "germs of the coli group" is used. These must no longer be neglected in the assessment of water cultures. In the assessment of river water and of drinking water, different criteria should be applied for the demonstration of "germs of the coli group." In this connection, certain proposals are made.—*PHEA*

Methods of Measuring the Coliform Content of Waters. A Progress Report. J. A. McCarthy; J. E. Delaney; & R. J. Grasso. *Sanitalk,* 2:16 ('60). Intensive study of 20 types of coliforms on membrane filter using Endo medium showed, in an earlier work, that this was the best method available. Inclusiveness of the method is shown by recoveries ranging from 33–100% by total colony growth and 0–100% by sheen formation. Selectiveness is shown by failure to verify 411 colonies of 1,750, or 23.5%. It is questionable if any medium can be 100% inclusive and, at the same time, 100% selective. Accumulation of volatile acids was found to be closely associated with the formation of sheen, but this is not the only factor. Stimulation of formation of volatile acids was afforded by addition of malic acid, fumaric acid, and pyruvic acid to medium. All tend to produce overgrowth and loss of sheen in rapid fermenters of coliform group. Additions of these acids and saccharose and maltose to enrichment broth was found definitely stimulatory to weaker fermenters without destroying the sheen of stronger and faster fermenters. Use of a semi-solid medium is being studied. It offers advantages of better storage, better humidity control, and reduction of byproduct migration.—*PHEA*

The Rapid Identification of *Escherichia coli I* by the Production at 44°C of Both Indole and Gas From Lactose. J. Papavassiliou. *J. Appl. Bacteriol.,* 21:104 ('58). The modification of the 44°C test proposed by Mackenzie, Taylor, and Gilbert ('48) is useful for the rapid identification of *Esch. coli I* in water and foods. False positive tests caused by other coli-aerogenes bacteria, or by their association with other organisms, can be considered rare. Only a few *Esch. coli I* fail to produce indole or ferment lactose at 44°C, and further confirmation for routine purposes is necessary only when the results at 44°C are discordant—for example, indole positive-lactose negative or indole negative-lactose positive.—*PHEA*

Coli Index and Fungal Microflora in Waters of Varying Degrees of Contamination. I. A. Mikhaliuk. *Mikrobiologiya* (Moscow), 27:724 ('58). A study of fungal microflora was undertaken to establish connections with the coli index (I) and with contamn. of water by org. substances. Thirty varieties of fungi were detected in rivers, ponds, wells, and tap water. Most common were *Mucoraceae,* but some *Trichoderma, Penicillium, Aspergillus, Fusarium,* and *Alternaria* were found. Higher no. of fungi present were invariably accompanied by a higher I and higher bacteria counts (II). Chlorination reduced the no. of fungi; in waters left to settle or filtered without chlorination the fungi remained unchanged.

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I and II detns. remain the most practical methods for checking water contamn., but full assay of fungal microflora is recommended where more precise characteristics of water reservoirs are required.—*PHEA*

A Study of Methods of Isolation of Salmonella Organisms From River Water, Sewage, and Mud. S. Heinrich & G. Pulverer. *Z. Hyg. Infektionskrankh.* (Berlin), 145:529 ('59). A simple enrichment method for detg. salmonellae in sewage, river waters, and mud is described. The method has been developed in the course of investigations on the question of elimg. these organisms from sewage through clarification. The procedure is based on using a 10-times concd. nutrient soln. and allows a relatively large yield with a proportionately small outlay of labor and materials, which makes it specially suitable for routine work. For the quantitative estimation of the salmonella load of water or mud samples, a salmonella titer can be detd. by this method.—*BH*

Bactericidal Effect of Silver in Water. K. Wuhrmann & F. Zobrist. *Schweiz. Z. Hydrol.* (Zurich), 20:218 ('58). The bactericidal effect depends on Ag concn., temp., pH, concn. of Cl^-, PO_4^{---}, and Ca^{++}, and O content. The test organism was *Esch. coli.*—*CA*

The Effect of Chemical Coagulation Upon Microrganisms. A. Orlita. *Vodni hospodarstvi,* 10:70 ('60). During the coagulation of tannery wastes with a $Fe_2(SO_4)_3$ and lime soln., the no. of ciliates and bacteria in the activation tank is reduced. Expts. to ascertain the substance which has the toxic effect were made, using infusoria (genus *Lionotus*), *Esch. coli,* and *B. megatherium,* and psychrophile bacteria from sewage. The toxicity is caused by the effect of different iron concns. at different pH values. A statistical evaluation shows that, for effective biol. final treatment, the pH value should not be higher than 8.6 and the concn. of Fe^{III} 20 and of Fe^{II}, 20 mg/l.—*CA*

(*Continued on page 70 P&R*)

(*Continued from page 68 P&R*)

The Specific Bacteriological Pollution of Water Courses by Sewage From Penicillin Factories. D. CORNELSON ET AL. *Arch. roumaines pathol. exptl. microbiol.,* 17:271 ('58). At points upstream and 3 and 19 km. downstream from a penicillin factory, 0.7, 30, and 5%, resp., of the bacteria were resistant to 1,000 I.U. ml of penicillin. The resistant organisms from the factory sewage were mostly gram-neg. bacilli which produced large amts. of intra- and extracellular penicillinase. A city of 120,000 on the same river contributed sewage composed mainly of gram-pos. bacteria, of which only 1% were penicillin-resistant.—*CA*

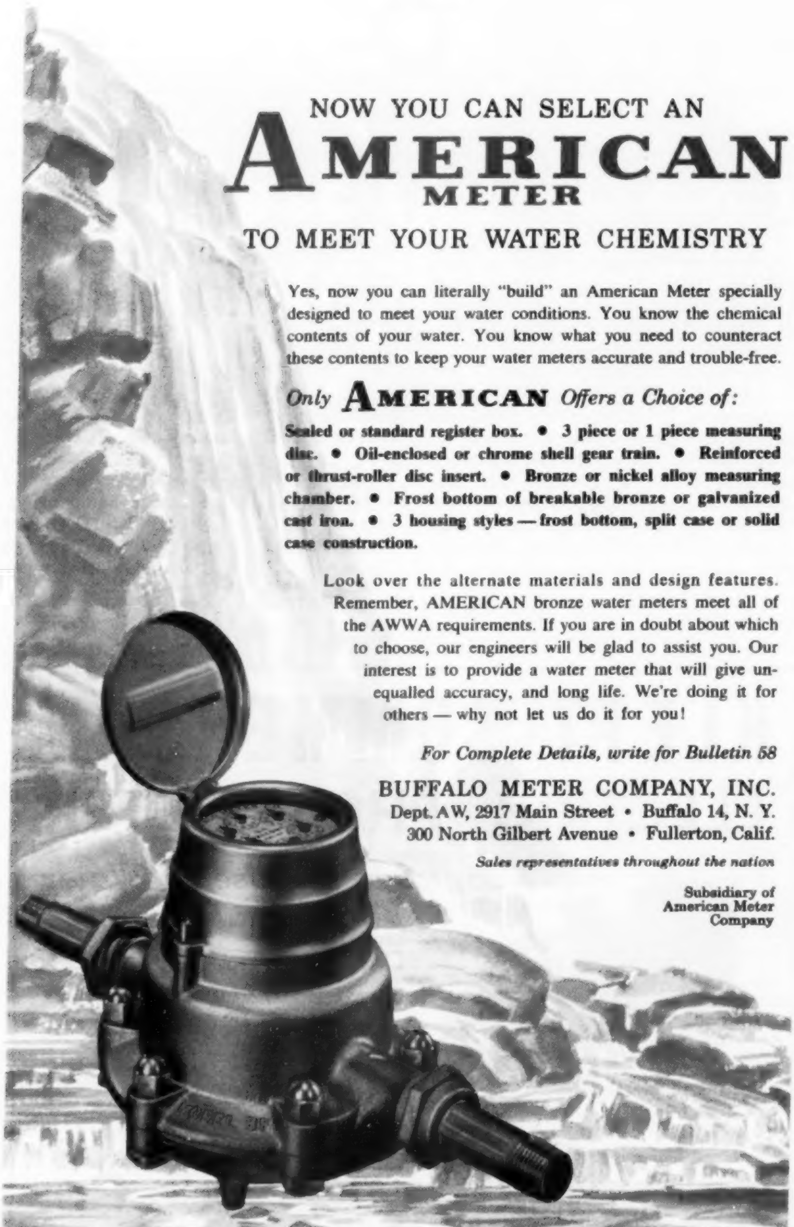
The Inactivation of Spores of *Bacillus globigii* and *Bacillus anthracis* by Free Available Chlorine. A. R. BRAZIS ET AL. *Appl. Microbiol.,* 6:338 ('58). This work, conducted at a san. eng. center of USPHS, was designed to afford "practical information on water treatment plant operation in times of disaster." It affords detailed information about the concns. of available chlorine required to kill spores of *Bacillus anthracis* and *B. globigii* in water in different periods of time, at different temps., and at different pH levels from 6.2 to 10.5. *B. globigii* was found to be more resistant than *B. anthracis,* except at pH 9.5 or more (when in any case the effective concn. of chlorine is impracticably high): it is therefore considered a satisfactory "index organism."—*BH*

Further Observations on the Bacterial Content of Water in Watercress Beds. L. A. E. BAKER & E. BILLING. *J. Appl. Bacteriol.,* 21:4 ('58). The information on the bact. cont. of water in watercress beds has, so far, been limited to the examn. of a few samples from each bed. In order to obtain more detailed information on the fluctuations in the bact. quality of the water, the authors selected 2 watercress beds and examd. water samples collected frequently over a period of 1 year. They confirmed previous findings that even in comparatively well-protected beds the *coli-aerogenes* cont. of the water may be high in summer. Also, in circumstances where poln. is suspected, they showed that the *coli-aerogenes* cont. can be low in winter. The season appears to influence the cont. in the water of *coli-aerogenes* bacteria, pectate-liquefying bacteria, and those capable of growing at 37°C. But in the case of those growing at 22°C, other factors appear to play a more important part—for example, higher counts were not uncommon in winter. Seasonal effects were less marked in water samples collected at the inlets to the watercress beds. The bact. counts increased as the sampling point moved from inlet to outlet.—*BH*

Influence of Bacteria on Oxygen Distribution in Small Bodies of Water. K. W. KUCHAR. *Sydowia Ann. Mycol.* (Austria), 11:327 ('57). In small bodies of water investigated for O distribution, stratification was found to be totally unrelated to the O level. The homogeneous distribution of O in unstratified water remained unchanged, even when strong bact. development was observed; such localities are neither favorable nor unfavorable to aerobic or anaerobic activity.—*CA*

The Toxic Effects of Waste Water on Aquatic Bacteria, Algae, and Small Crustaceans. G. BRINGMANN & R. KUHN.

(*Continued on page 72 P&R*)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Gesundheits-Ing. (Ger.), 80:115 ('59). The effect was detd. of many inorg. salts and org. compds. on the acid production by *Esch. coli,* on the propagation of *Scenedesmus quadricauda,* and on the mobility of *Daphnia magna.* By using this method, the effect of various industrial wastes on the aquatic fauna can be detd. before the wastes are released into the streams.—*CA*

The Effects of Residual Water on the Survival of Dried Bacteria During Storage. W. J. Scott. *J. General Microbiol.,* 19:624 ('58). After primary drying of bacteria, the unsealed ampules were placed inside larger tubes (which were sealed later) contg. substances of known water activity. After storage at 25°C, ampules were opened at intervals and viable counts were made on the dried material. When the test organisms (*Staphylococcus aureus, Pseudomonas fluorescens*) were dried in casein digest medium, the best survival was obtained with a trace of residual moisture. Salmonella Newport survived well in casein digest when the moisture content was low and the ampules were sealed *in vacuo;* but when sealed in air the relations between survival and water cont. were reversed within the limits tested. The addition of glucose or sucrose to the suspending fluid was beneficial, and the drier the end product, the better the survival of the test organism. Those interested in the preservation of bacteria by freeze-drying should read this paper for details.—*BH*

Biological Purification of Phenolic Waters. S. Landa. *Gaz, Woda i Tech. Sanit.* (Prague), 33:431 ('59). The *Esch. coli* strain isolated from the Veltava River decompd. PhOH, 50–100 mg/l PhOH, pH 5.8, at the max. rate of 100 mg/l/hr PhOH. Time required to decomp. *o*- and *p*-cresol, *m*-cresol, and 2,3-xylenol, resp., was 2–5, 7–17, and 12 times as long; 2,4- and 2,5-xylenol failed to decomp. The oospore mold which had been grown on a liquid medium contg. $KH_2PO_4 \cdot 2H_2O$ 1.770, Na_2HPO_4 0.060, $(NH_4)_2SO_4$ 100, $MgSO_4 \cdot 7H_2O$ 2.500, and pyrocatechol 2 g, and adapted during several

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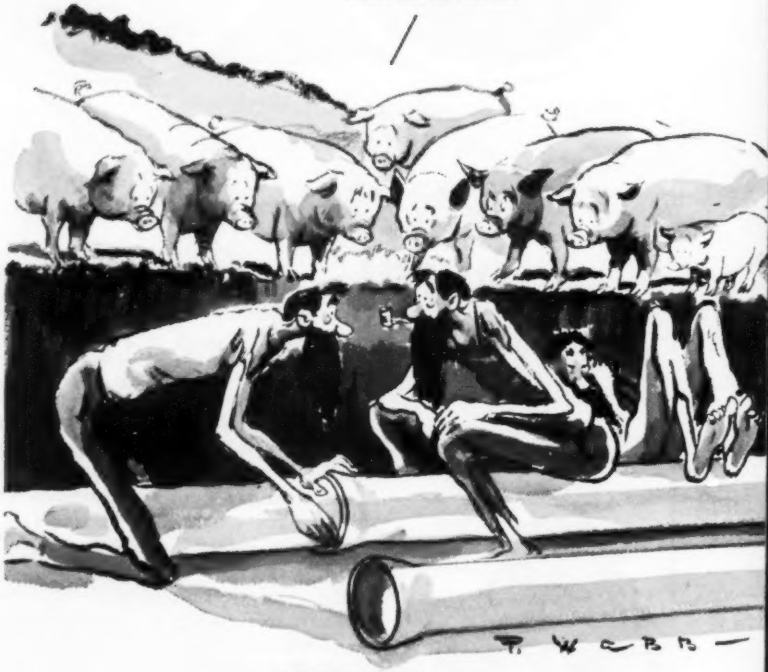
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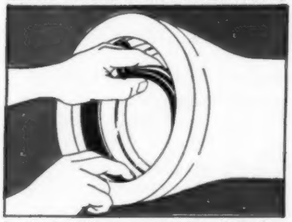
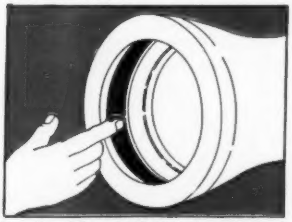


Insert gasket with groove over bead in gasket seat . . . a simple hand operation.



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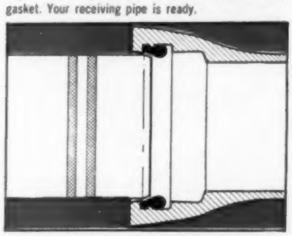
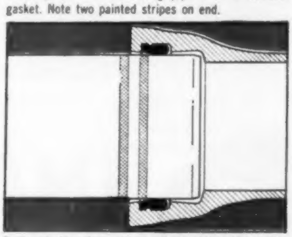


Insert plain end of entering pipe until it touches gasket. Note two painted stripes on end.



Push entering pipe until the first painted stripe disappears and the second stripe is approximately flush with bell face. The joint is sealed . . . bottle-tight, permanently! The job's done . . . . fast, efficiently, economically. Could anything be simpler?

(*Continued from page 72 P&R*)

months by successive passages to PhOH alone, 3 g/l, as nutrient, decompd. PhOH, *o*-, *m*-, *p*-cresol, 2,3-, 2,4-, and 2,5-xylenol in concns. of 100 mg/l (1,000 mg/l) at the following avg rates: 11–30 (32), 5 (1.5), 2 (1.5), 6 (2.3), 3 (2.1), 1.4 (1.1), and 1.4 mg/l/hr (1.3 mg/l/hr), resp.—*CA*

Some Microbiological Studies of Galichskoe Lake Sapropel Deposits. L. D. Shturm. *Trudy Lab. Sapropelevykh Otlozhenii* (Moscow), No. 7, 89 ('59). Bacteria, aerobic as well as anaerobic, though present in all the sections studied, belong essentially to the upper horizon. Processes, such as albumin decompn. (formation of H_2S, NH_3, indole, skatole, and a lack in mercaptans are characteristic), N fixation (only aerobic, *Clostridium pasteurianum*, bacteria are found), both butyric and cellulose fermentation, desulfuration, particularly intensive in the upper horizon, take place also in the lower strata, causing an intensive decompn. of sapropel org. matter. Mineral admixts., such as Ca, increase with the formation of NH_3. Some areas in sapropel deposits differ in the presence of FeS deposits formed by the interaction of Fe and H_2S, the latter proceeding from sulfate reduction by desulfuration bacteria.—*CA*

The Concentration of Bacteria Suspended in Water With the Help of a Soluble Ultra-Filter. D. Schyma. *Zentr. Bakteriol.* (Ger.), 178:229 ('60). A method is described for the prepn. of a sol. aluminium alginate membrane filter suitable for use in the bacteriologic examn. of water. The starting material is a commercial sodium alginate powder "Protanal HF." 10 g of this powder added to 990 ml of distilled water and left overnight gives a viscous yellow fluid which can be stored in the refrigerator for 4 weeks. A thin layer of this soln. is spread mechanically to a depth of 0.7 mm on the surface of a sheet of filter paper, of appropriate size, previously soaked in a molar soln. of aluminium chloride. After 1.5 min, the gel formed on the filter paper surface is washed in water, autoclaved between two sheets of filter paper, and kept under water until required. The alginate membrane formed in this way is a water-clear gel in a sheet of thickness 0.5 mm. It is composed of two distinct zones, a primary gel membrane 20μ in thickness, which is the effective filtering component, and a secondary supporting zone containing capillary channels of diameter 20–25μ, which run at right angles to the primary membrane. The membrane is completely impermeable to bacteria, and also holds back colloidal gold particles of only 20 mμ in diam. Water is filtered through it under slight negative pressure. The membrane is then dissolved by immersing it in a soln. of 3.8% neutral sodium citrate soln., which was shown to be quite innocuous to bacteria and even to tissue cultures.—*BH*

The Use of Polystyrol Products in Drinking Water Pipes. Bacteriological Investigations. B. Schmidt. *Zentr. Bakteriol.* (Ger.), 178:381 ('60). A short review of the literature on the use of various plastic materials for drinking-water pipe introduces the work described in this paper. The object of this investigation was to detn. whether the use of polystyrol for the manufacture of app. employed in the lab. for the measurement of bact. numbers might have the effect of increasing bact. counts by causing multi-

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plication of the organisms. The expts. carried out are fully described. They consisted of: (1) comparison of bact. counts in mains water with and without addition of polystyrol in granular form; (2) similar comparison in mains water inoculated with hemolytic *Staphylococcus aureus* or with *Esch. coli;* and (3) comparison of counts in Sohngen soln. (NH_4Cl, K_2HPO_4 and $MgSO_4$ in distilled water) inoculated either with the same organisms as in (2) or also with typical water bacteria with and without polystyrol. The expts. were carried out at 4°C, 20°C, and 37°C. The results of the expts. do not provide any evidence that polystyrol has any effect on bact. counts by acting as an additional nutrient for the organisms.—*BH*

Investigations on the Bacterial Oxidation of Sulfur in the Elbe. B. Mutze & H. Engel. *Arch. Mikrobiol.* (Ger.), 35:303 ('60). Since 1958, samples of water taken monthly from the Elbe between Schnackenburg and Hamburg have been tested for their capacity to oxidize added sodium thiosulfate. The results are analyzed according to the position in the river, season, and flow, and the responsible bacteria were identified. It is shown that the oxidation of thiosulfate is a biologic process and that its extent can be used as a relative measure of the number of sulfur-oxidizing bacteria present. In the Elbe, the capacity to oxidize thiosulfate decreased continuously from Schnackenburg to just above Hamburg, increased suddenly in the Hamburg harbor region, and decreased again further down stream. Samples showed oxidizing action throughout the year, though in the stream itself the responsible microorganisms were almost wholly inactive in the cold weather. The action was strongly affected by flow, decreasing at high water and increasing at low water. Below Wedel, sulfur-oxidizing bacteria were scarce. Most of the sulfur-oxidizing bacteria are probably introduced in waste waters. *Thiobacillus thio-oxidans* and *Th. denitrificans* were identified.—*WPA*

Bacterial Destruction of Sodium Nitrite in Open Cooling-Water Systems. D. G. Lundgren & A. Krikszens. *Appl. Microbiol.,* 7:292 ('59). Preliminary studies are described on the bact. destruction of sodium nitrite used to control corrosion in open cooling systems. The mechanism of nitrite loss was found to be oxidation of nitrite to nitrate by *Nitrobacter agilis.* The ability of various compds. to stabilize nitrite against bact. oxidation was investigated. Only 2 compounds—sodium azide and Preventol GDC—were able to stabilize nitrite for more than 20 days.—*WPA*

A New Approach to the Study of Marine Bacteria in Gulf and Atlantic Waters. C. A. Bryan & A. H. Bryan. *Ecology,* 40:712 ('59). In an attempt to devise new techniques for more accurate study of marine bacteria and to obtain data on their incidence, classification, and biochemical activities, a large number of water samples were taken at various depths in the Gulf of Mexico and in the Atlantic coastal waters of Florida. The methods of sampling and analysis are described. It was found that salt-water-based nutrient agar supported varied and luxuriant growths of bacteria and aquatic fungi. The numerical incidence of the bact. flora appeared to be directly proportional to the cont. of suspended org. matter and plankton. Larger numbers of bacteria occurred in bottom samples than in clear surface waters. The various species identified are listed.—*WPA*

Bacterial Analysis of Water by the Membrane Filter Technique. E. Novel & P. Burkard. *Mitt. Lebensm. Hyg.* (Ger.), 50:188 ('59). Studies have been carried out on the use of the membrane filter technique for the bact. analysis of water to detn. the effect on counts of *Esch. coli* of the method of sterilization of the app., the storage of the sample, the type and method of sterilization of the membrane, the type of nutrient medium, and the period of incubation. It was found that the method of sterilization has no effect on the count, and that bact. suspensions are stable for 3–4 hr at 4°C. Lower counts were obtained with MacConkey, eosin methylene blue, and desoxycholate media than with the other media exmnd.—*WPA*

The Differentiation of Coliform Bacteria Isolated From Drinking Water. H. Habs & H. Muller. *Arch. Hyg. u. Bakteriol.* (Ger.), 144:1 ('60). In the examn. of coliform bacteria isolated from water sam-

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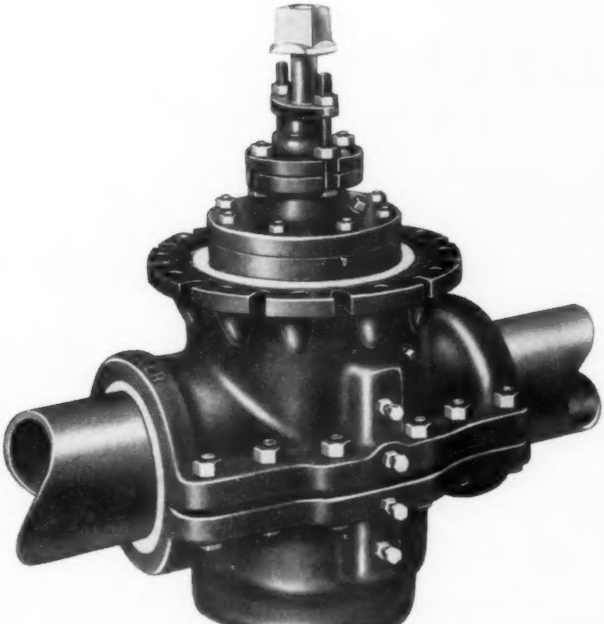

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ples, it was found that the types which occur most frequently—namely, species of *Esch.* (*Citrobacter*) *freundii* and *Aerobacter* (*Cloaca*) *cloacae*—cannot all be identified by the IMViC reactions, and consideration should also be given to production of gas from glucose at 45°C, production of hydrogen sulfide, and liquefaction of gelatin. Classification schemes used in water bacteriology must be adjusted to the modern classification of Enterobacteriaceae which does not place the highest importance on lactose fermentation. The classification of lactose-fermenting strains also requires further investigation.—*WPA*

Lake Water and Sediment. VI. The Standing Crop of Bacteria in Lake Sediments and Its Place in the Classification of Lakes. F. R. Hayes & E. H. Anthony. *Limnol. & Oceanogr.*, 4:299 ('59). With a view to detmng. whether bacteria could be used as an index of the productivity of lakes, studies are in progress on the reliability of bact. counts and on the relation between bact. numbers and other factors in lakes of different character. The app. and procedure used for detmng. bacteria in lake water and bottom sediments by the membrane filter technique are described. It is calculated that a single sample would give an error of ±130%, but by taking samples at 4 different times the error could be reduced to ±36%. There was no significant reduction in bact. nos. with depth in the first 5 cm of the bottom mud; below this, a gradual reduction in nos. was observed. In clear-water lakes, the bact. counts were found to be closely related to factors thought to be connected with productivity, such as methyl orange alkalinity, conductivity, and oxygen consumption over mud. However, brown-water lakes were found to have high bact. counts, although they are low in alkalinity and conductivity. In these lakes, the bact. count was found to be closely related to the color of the water, and it is suggested that this could be used to detn. what part of the bact. count in any lake is to be attributed to bog. By subtraction of the bog fraction, the true measurement indicative of productivity could be obtained.—*WPA*

Studies on the Chemoautotrophic Iron Bacterium *Ferrobacillus ferro-oxidans*—II. Manometric Studies. M. P. Silverman &

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D. G. Lundgren. *J. Bact.*, 78:326 ('59). The physiological properties and iron-oxidizing system of the obligate chemoautotrophic bacterium *Ferrobacillus ferro-oxidans* were studied manometrically using intact cells. Ferrous ions were oxidized at an unusually rapid rate; endogenous metabolism did not occur. The optimal conditions for the iron-oxidizing system were pH 3.0–3.6 and temp. 37°C (although no growth occurred at this temp.). The oxidizing action of the cell suspensions increased with increasing concns. of ferrous ions in the range 50–500 μmoles per Warburg vessel (that is 1,860–18,598 ppm), although it had been found previously that concns. as high as 18,000 ppm decreased the rate of growth. During the oxidation of 50 μmoles of ferrous ions, carbon dioxide was assimilated with an average efficiency of $20.5 \pm 4.3\%$. The rate of oxidation of iron was depressed by phosphate, even when present at a concn. of only $0.002M$; and by a citrate, the depression reaching a max. at a concn. of about $1 \times 10^{-2}M$. Ammonium, thiosulfate, di- and tetravalent manganese, cobalt, and nickel ions were not oxidized by this bacterium; elemental sulfur showed slow but significant oxidation, although the rate of oxidation was reduced when the flask was not shaken.—*WPA*

Some Bacteriological Aspects of Sewage Pollution of Bathing Beaches. B. Moore. *Roy. Soc. Promotion Health J.*, 79:730 ('59). This paper is an address at an Isle of Wight meeting of the Royal Society of Health in which the author discusses the dangers of accepting bact. findings arising out of the general use of the coliform test in water examns. without a very full understanding of all the problems involved. In other words, the level of contamn. by fecal *coli* of a particular sample of sea water cannot be judged in terms of drinking water standards; but considered in relation with a number of other factors it can be a useful guide in certain sanitary engineering projects. In considering the risks of bathing in sea water which is contaminated by sewage, it is not so much the fact that a certain pathogenic or-

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ganism is present in the sewage that is of prime importance but whether its presence there constitutes a potential danger to health as a practical proposition rather than a theoretical possibility. A bathing beach may be condemned on aesthetic grounds with justification, but condemnation on bact. findings without the fullest support from an intensive study by experienced epidemiologists is to be deprecated.—*BH*

The Significance of the So-Called Atypical Coliform Bacteria in the Examination of Water. H. Habs & H. Langeloh. *Arch. Hyg. u. Bakteriol.* (Ger.), 142:401 ('58). The authors compared the no. of typical and atypical *Esch. coli* in 6,506 samples of water collected from the area controlled by the Hygiene Institute of Heidelberg. A total of 2,206 coliform strains was isolated and, of these, 68% were typical *Esch. coli.* Of the atypical *coli* strains present, 62% belonged to the type *E.* [*Citrobacter*] *freundii.* A comparison between the general colony count and the coliform and coli contents was made, and a statistical correlation was found. Samples of water from sandstone wells which only rarely showed an increase in the colony count sometimes showed atypical *Esch. coli* which heralded the appearance of typical *Esch. coli* after heavy rain. The bact. results were in accordance with what might have been expected from the topographic situation. The authors conclude that the presence of atypical *Esch. coli* is not so much an indication of fecal contamn. but serves as ground for objection to the water because of the knowledge which this bacterium implies —namely, that insufficiently filtered surface water has gained access to the source.—*BH*

A Handy Hydro-Mechanical Sampling Apparatus for the Bacteriological Examination of Water. P. Kraus. *Zentr. Bakteriol., Parasitenk.* (Ger.), 172:458 ('58). A simple app. is described which permits precise sampling of water from a deep well for bact. analysis. It is both guided and operated by a single cable and can be used with any sample bottle of convenient size, provided that this has a stopper that can be gripped by the jaws of the app. The paper is well illustrated by diagrams and photographs.—*BH*

Evaluation of the Reliability of Coliform Density Tests. J. A. McCarthy; H. A. Thomas Jr.; & J. E. Delaney. *Am. J. Public Health,* 48:1628 ('58). The 2 general methods of estg. the coliform cont. of a water sample are the inoculation of multiple tubes of liquid medium to obtain the "most probable number" (MPN) or a direct colony count in a solid medium. There is a considerable error in the MPN estimate —for example, with 5 tubes for each dilution, the figure may be 260% above or 70% below the true count. On the other hand, there are serious limitations with the direct colony count method—for example, the amt. of sample is very small, other organisms may be erroneously identified as coliform organisms, and there is possible inhibition of certain strains when selective media and selective techniques are used. The precision of plate counts in the range of coliform densities investigated by the authors, however, was found to be at least 3 times as great as the MPN result. The direct count approach will give even more accurate results with the membrane filter technique.—*BH*

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The Differentiation of Coliform Bacteria Isolated From Drinking Water. H. HABS & H. MULLER. *Arch. Hyg. u. Bakteriol.* (Ger.), 144:1 ('60). The IMViC reactions used to classify coliform bacteria isolated from water were not sufficient to identify all the species of *Esch.* (*Citrobacter*) *freundii* and *Aer.* (*Cloaca*) *cloacae*, types which occurred most frequently in the samples. Production of gas from glucose at 45°C, production of hydrogen sulfide, and liquefaction of gelatin are also important for routine differentiation. The scheme of classification still common in water bacteriology must be adjusted to the modern classification of Enterobacteriaceae, which does not place the highest importance on lactose fermentation. On the other hand, the classification of lactose-fermenting strains requires further investigation.—*BH*

Microbiological Determination of Dilution of Mineral Sedimentation Waters in the Region of Surface Infiltration. M. SPURNY; M. DOSTALEK; & J. JURANEK. *Prace ustavu pro naftovy vyzkum* (Prague), 9:81 ('58). The purity of these waters was measured by a coeff. of biochem. reduction, which is the ratio of sulfate-reducing bacteria to heterotrophic aerobic bacteria. The results thus obtained were similar to those where oxidation-reduction potential was measured. Hydrogen sulfide waters (31) were analyzed, mostly from the Gottwald region.—*CA*

SWIMMING POOLS AND BEACHES

Purification and Disinfection of Bath Water. O. FISCHINGER. *Gas, Wasser, Waerme* (Ger.), 12:97 ('58). The chem., phys., and bacteriol. requirements of swimming bath water are discussed and methods of treatment by coagulation and filtration are described. The author then deals with the principles and operation of disinfection by chlorine gas, hypochlorite, and chlorine dioxide.—*WPA*

Improvement of Quality of Water in Swimming Pools. Y. KAO. *Tung Chi Ta Hsueh Hsueh Pao,* 3:40 ('58). Water treatment to improve color and turbidity, and for hygienic purposes, was studied. In the swimming pool, the efficiency of water treatment within a certain limit is independent of the alkalinity of the water medium. About 10 g/l $Al_2(SO_4)_3$ is used for coagulation; corrosion is reduced, if necessary, by use of Na_2CO_3. $CuSO_4$ is used to reduce mold growth, and liquid Cl is applied for sterilization.—*CA*

Some Bacteriological Aspects of Sewage Pollution of Bathing Beaches. B. MOORE. *Roy. Soc. Promotion of Health J.,* 79:730 ('59). The justification for strictness in bact. requirements in water examn. is discussed, along with the often unwarranted use of the coliform test on milk and sea water. It is useful in plotting the extent of contamn. associated with a bathing area and the effect of dilution, wind, and other factors on sewage at an outfall point. Lab. and epidemiologic data on sewage-polluted sea water must be studied carefully before deciding upon the health risk of bathing in it. The risk of deciding whether such diseases as typhoid fever or poliomyelitis can be contracted by bathing must be viewed by reference to the overall picture of these diseases in the affected communities.—*PHEA*

Effectiveness of Iodine for the Disinfection of Swimming Pool Water. A. P. BLACK; J. B. LACKEY; & E. W. LACKEY. *Am. J. Publ. Health,* 49:1060 ('59). Iodine is more effective than chlorine and has no unpleasant side effects. Sampling methods and bacteriol. and chem. lab. methods of analysis are given.—*CA*

Pool Water Clarity and Filter Performance. *Swimming Pool Age,* 33:44, 80 ('59). Several types of diatomaceous earth filter used for the purification of swimming-bath water (including cylindrical element, leaf type, and vacuum filters) are described, and operational difficulties most commonly encountered are enumerated. Filtration rates are discussed, and a rate of 1.5–3 gpm/sq ft of filter area is recommended as providing the most economical operation. Chlorination and other chemical treat. methods are reviewed briefly.—*WPA*

Chlorine, Ideal Pool Water Disinfectant? E. J. LAUBUSCH. *Swimming Pool Age, 32*: 26, 62 ('58). The chlorination of water in swimming baths is discussed from the point of view of being the best method for the removal of health hazards to bathers. Fac-

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tors controlling chlorination—namely, its method of application, the source of chlorine, the influence of the pH value on its availability, the concn. of org. matter in the water, and the presence of free residual chlorine—are considered. Preliminary chlorination before filtration is considered to be most satisfactory; but it is pointed out that care must be taken to avoid the escape of chlorine gas which would be detrimental to bathers. Regulations under state laws are reviewed and their variability noted; it is stressed that there is a need for uniformity in the regulations.—*WPA*

Complex Analysis of the Water of Swimming Pools. W. N. Ghelberg et al. *Igiena* (Bucharest), 8:1 ('59). An analysis of 4 swimming pools was carried out at the beginning and at the end of the season by detg. the temp., dissolved O and O satn., the transparency at the Secchi disk, coloration according to the Forel-Uhle scale, the pH, the permanganate and Cl consumption, the NH_3, the nitrites, and the no. of bacteria and coliforms. Based on the results, the following sanitation measures were suggested: the pools must be filled with water of the quality of drinking water; the water must be continually chlorinated; if the water cannot be renewed daily, it must be recirculated and treated; $CuSO_4$ must be used for the elimination of algae; and the water must be checked regularly by a complex lab. analysis.—*CA*

Loss of Algicidal Chemicals in Swimming Pools. G. P. Fitzgerald. *Appl. Microbiol.*, 8:269 ('60). Tests have been reported which were designed to demonstrate the adsorption of 4 quaternary ammonium compds., Cu compds., a quinone, 2 amines, and a pyrimidine on a diatomaceous filter aid (Celite) when contact for 1 hr at 23°C was used as adsorption period. The alga used for the toxicity studies (after adsorption of the test solns. on the filter aid) was *Chlorella* (Wisconsin strain). Among prepns. studied were: hexadecyltrimethylammonium bromide, (*p*-diisobutylphenoxyethoxyethyl)dimethyl-

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benzylammonium chloride monohydrate, (alkyl(C_9–C_{15})tolylmethyl)trimethylammonium chloride, dodecylpyridinium chloride, 2,3-dichloro-1,4-naphthoquinone, Rosin Amine D acetate, 5-amino-1,3-bis-(2-ethylhexyl)-5-methylhexahydropyrimidine, $CuSO_4$, Cu dihydrazinium sulfate. The loss was between 50 and >67% of the compd. in soln. Algicides should be added to swimming pools at frequent intervals.—*CA*

Determination of the Quantity of Oily Substances on Beaches and in Nearshore Waters. I. J. Foxworthy & R. Stone. *Calif. State Water Pollution Control Board, Publ.* No. 21, 1 ('59). Oily substances of a tarry nature are found along California beaches. Methods for the sampling of such beaches and the estn. of the tarry substances therein are discussed. The tarry materials are collected, subjected to a Soxhlet expt. with $CHCl_3$, and the residue is weighed after distn. of the $CHCl_3$. Old deposits could be differentiated from fresh deposits by the facts that fresh deposits were sticky, soft, and pliable, and would leave an oily film on the finger. Old deposits did not exhibit these characteristics. Old sand-impregnated deposits retained their shape and consistence at elevated temps. These old particles were denser than fresh ocean water and would sink, while the fresh particles were less dense and would float. Crude oil and material from an off-shore oil seep both took on an appearance similar to the tarry deposits after test weathering. Refined oils did not react in this manner. In these studies most beaches were found to contain ≦2 oz of oily material/500 sq ft of beach. The Santa Monica Bay area and the Coal Oil Point area, both subject to pollution by oily materials, contained >2 oz/500 sq ft of beach. A sampling device to measure the oily substances in the near-shore waters was devised. This consisted of a float from which was suspended a submersible pump. The pump discharge was filtered through excelsior pads and returned to the ocean. Preliminary tests showed the presence of less than 0.1 ppm of oily substances in the ocean water.—*CA*

Water Treatment in Open-Air and Indoor Swimming Baths. H. Artz. *LitBer. Wass. Abwass. Luft u. Boden* (Ger.), 7:16 ('58). From a critical examn. of the requirement that a swimming bath water should be clear and hygienically satisfactory at every point, the author concludes that treated water should be introduced at the deepest part and not at the shallow part where addition of poln. is greatest. To avoid over-chlorination, he suggests that, when separate types of baths (diving, swimming, and nonswimming) are connected, chlorine should be added at the inlet and between the different baths in amounts such that the required excess is present at the end of each section. The frequently used method of separate recirculation of the water from each bath can then be avoided. The importance of correct design is emphasized.—*WPA*

DAMS AND RESERVOIRS

A Biological and Chemical Study of the Chew Valley Lake. C. Hammerton. *Proc. Soc. Water Treatment Exam.*, 8:87 ('59). The purpose of the study was to record the biol. and chem. changes in the stored water during the early years of the new reservoir

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and to make a detailed examn. of the problem of biochem. stratification of this reservoir. The principal changes that took place during this stratification were the disappearance of O, the liberation of NH_3, PO_4, SiO_2, H_2S, CH_4, and CO_2, an increase in alky., and the appearance of Fe and Mn in soln. The principal cause for the stratification is the high content of org. matter in the bottom mud of the lake. A detailed biology of the lake during this study is given with the growths of 31 spp. Bacillariophyceae, 9 spp. Chlorophyceae, 1 spp. Xanthophyceae, and 5 spp. Myxophyceae observed. Crustacea and chironomid midge flies were encountered.—*CA*

Sanitary Rules for the Discharge of Rain and Snow Water into Water Reservoirs. S. S. Bliokh & N. S. Vigilev. *Gigiena i Sanit.* (Moscow), 23:59 ('58). The article constitutes a review of the potential contamination of H_2O supplies from rain and melted snow.—*CA*

Limiting Concentration of Metaphos in Reservoirs. E. V. Lisovskaya. *Gigiena i Sanit.* (Moscow), 23:19 ('58). The recommended limit of metaphos in water is 0.02 mg/l, which is its lowest concn. detectable by odor. Nitrification is somewhat inhibited by 1 mg/l, and the BOD is noticeably suppressed by 20 mg/l. While not affecting the physiol. functions of warm-blooded animals, a concn. of 20 mg of metaphos per liter causes displacements of the functional state of the cerebral cortex, resulting in an increased latent period, a decreased motor response of the conditioned reflexes, and the appearance of phase states. —*CA*

Derwent Reservoir Project for Durham County Water Board and Sunderland and South Shields Water Company. *J. Brit. Waterwks. Assn.*, 42:185 ('60). The first and largest project of the Derwent Scheme —namely, an earth dam across the river Derwent (a southern tributary of the river Tyne) on the boundary between Durham and Northumberland—is under construction. The complete Derwent Scheme, including the construction of the reservoir, water in-

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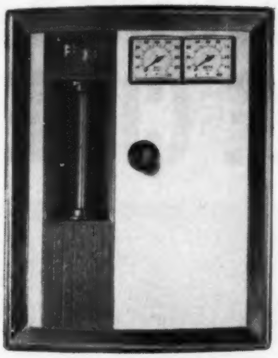

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1912 Denver—This 60-in. ID main was laid through a tunnel and over the South Platte River. The Water Department reports that despite a temperature range of 120 deg. "the pipe is in very good condition and is still giving satisfactory service."

1909 Springfield, Mass.—This 22,000-ft. 42-in. ID supply main is in its fiftieth year. Flow tests show, according to the Municipal Water Works, "that steel lines with proper coatings will give very long life as far as carrying capacity is concerned."

1899 Passaic Valley, N. J.—These are the giant steel penstocks at Little Falls pumping station. Since then the major portion of the water supply for the cities of Paterson, Passaic, and Clifton has passed through these venerable pipes.

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takes, and an aqueduct from the reservoir to a new water treatment plant, capacity 32 mgd, will be executed by the Sunderland and South Shields Water Co. for the joint benefit of the company and the Durham County Water Board. The ultimate net yield of the new reservoir is estd. to be 26 mgd, and this will be shared equally by the two undertakings. The treatment plant will consist of sedimentation tanks, rapid sand filters, chemical storage, and dosing equip., storage facilities for treated water, wash water recovery plant, and sludge-disposal facilities. The Durham County Water Board will pump its share of the water to a high-level service reservoir. Both undertakings will provide their own storage facilities and distribution systems.—*WPA*

FLUORIDATION

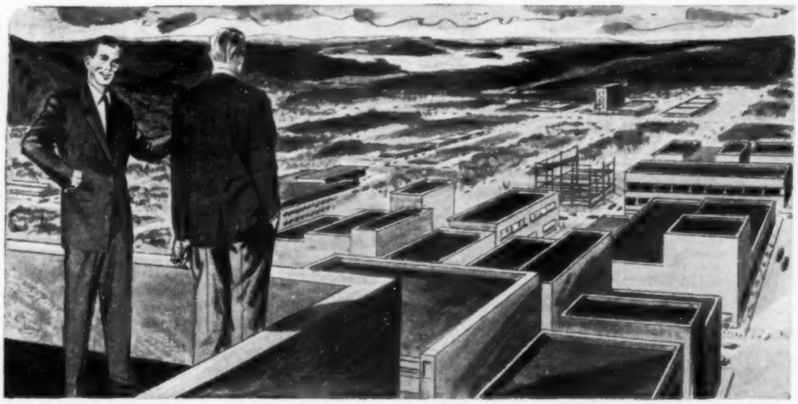
Five Years' Experience With Fluoridation in Norway, Maine. A. H. Garcelon. *New England J. Med.*, 260:127 ('59). The town of Norway, Me., began fluoridation of its water supply in Oct. 1952. About that time 191 children, 6–14 years old, were dentally examnd., and a similar examn. was carried out in 1957. During that period, the avg. no. of decayed, missing, and filled permanent teeth was reduced by more than ½ among children aged 6–9 years, by more than ¼ among those aged 10–12 years, and by about 1/10 among those aged 13–14 years. During the same period, the percentage of children aged 6–9 years who were entirely free from dental caries in permanent teeth more than doubled—the actual percentages being 18.0 in 1952 and 39.1 in 1957. There were not sufficient caries-free children in the 10–12 years age group to warrant any conclusions regarding an increase of freedom from caries in that group. The max. benefits of fluoridation occur when the fluoride is incorporated in the tooth enamel while it is being formed and, consequently, the younger children who had more of their teeth formed during the fluoridation period received greater benefit than did the older children.—*BH*

Fluorine Content of the Water Supply of the Kola Peninsula and Dental Caries of School Children. B. G. Afanas'ev. *Gigiena i Sanit.* (Moscow), 25:96 ('60). The F content of the surface waters ranges from 0.04 to 0.16 mg/l. Dental caries are frequent in the children, especially those children who do not leave the district during the summer. —*CA*

Fluoridation. A. S. Flemming. *Public Health Repts.* (*US*), 74:511 ('59). Progress in fluoridation of water supplies in the US during the past 2 years is discussed, and the importance of water fluoridation is stressed. Research on the effect of fluorine concn. in water supplies on the incidence of dental caries is reviewed, and the present status of fluoridation in the United States is outlined. The effectiveness, practicability, and safety of administering fluorine in milk, bread, salt, or in tablet form as alternatives to the fluoridation of water are discussed.—*WPA*

Fluoridation—The Experience in the Scottish Burgh of Kilmarnock. B. R. Nisbet. *Sanitarian, Lond.*, 68:259 ('60). The beneficial effects of the fluoridation of the water supplies of Kilmarnock, Scotland, one of the areas in Great Britain chosen to study fluoridation, are discussed. The study is incomplete, but results obtained so far indicate that the presence of 1 ppm fluoride in drinking water reduces the occurrence of dental caries. —*WPA*

Effect of Natural Fluorides on Caries Incidence in Three Georgia Cities. F. D. Lewis Jr. & E. C. Leatherwood Jr. *Public Health Repts.*, 74:127 ('59). Savannah, Ga., using water containing about 0.38 ppm fluoride, asked what would be the additional reduction in their caries attack rate if the fluoride level were raised to the optimum. To answer this question, the children in 2 other cities were examnd: Macon, Ga., with 0.11 ppm fluorides, served as the source of baseline data; Moultrie, Ga., with 0.75 ppm fluorides (the min. concn. recommended in Georgia) would indicate the rate which might be expected if Savannah's fluoride level were raised. The DMF rate at Moultrie was 60.8% lower than Macon's and 39.1% lower than Savannah's; Savannah's rate was 35.6% lower than Macon's. If, therefore, Savannah would raise the fluoride level of its supply to 0.75 ppm, the city could gain an additional 39.1% DMF reduction.—*PHEA*



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Oscar Gullans has been appointed assistant engineer of water purification for the Chicago Department of Water & Sewers. James C. Vaughn has succeeded him as chief filtration engineer at the South District Filtration Plant.

Morrison B. Cunningham has retired as superintendent of the Oklahoma City Water department to take over the position of manager of the city's Municipal Improvement Authority, which will develop a $62,000,000 project for long-distance transmission of water to the city. He has served the Association as director (1948–51 and 1955–56), vice-president (1953), and president (1954). He was presented with the Fuller Award in 1949 and became an Honorary Member in 1958. Frank S. Taylor, formerly his assistant, has been named acting superintendent.

Fairbanks, Morse & Co. announces the organization of a new water division, which will manufacture equipment for desalinization. John P. Henebry has been appointed director of the division.

Frank P. MacDonald has been appointed president of Electro Rust-Proofing Corp., subsidiary of Wallace & Tiernan Inc. He was formerly vice-president and sales manager.

Charles F. MacGowan, of Kansas City, Kan., has been selected as director of the Office of Saline Water by Stewart L. Udall, secretary of the De-

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partment of the Interior. Since 1954, MacGowan has been technical adviser and international representative of the International Brotherhood of Boiler Makers, AFL–CIO.

Harold S. Buttenheim, editor emeritus of *American City Magazine,* died on Jan. 11, 1961, in Madison, N.J., at the age of 84. Cofounder of the present Buttenheim Publishing Corp., he was editor of the magazine from 1911 to 1955.

John Wallace Grant, chief chemist for the West Virginia Water Co., Charleston, W.Va., died on Jan. 13, 1961, at the age of 57. Born in 1903, he received his A.B. from Glenville (W.Va.) State Teachers College and taught high school chemistry from 1933 to 1942, when he joined the West Virginia Water Service Co. as laboratory assistant.

A member of AWWA since 1945, he formerly served as chairman of the West Virginia Section.

William D. Turner, consulting chemical engineer, died on Feb. 24, 1961, in New York City, at the age of 72. Formerly head of the chemical engineering department at Columbia University, he had worked for the chemical firm of Airkem, Inc., from 1943 to 1951, when he retired. He was a member of AWWA since 1931.

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Chlorine Comparators:
Fischer & Porter Co.
Klett Mfg. Co.
Wallace & Tiernan Inc.

Chlorine, Liquid:
Olin Mathieson Chemical Corp.
Wallace & Tiernan Inc.

Clamps and Sleeves, Pipe:
James B. Clow & Sons
Dresser Mfg. Div.
Mueller Co.
A. P. Smith Mfg. Co.
Trinity Valley Iron & Steel Co.

Clamps, Bell Joint:
James B. Clow & Sons
Dresser Mfg. Div.

Clamps, Pipe Repair:
James B. Clow & Sons
Dresser Mfg. Div.
Trinity Valley Iron & Steel Co.

Clarifiers:
American Well Works
Dorr-Oliver Inc.
Eimco Corp., The
General Filter Co.
Infilco Inc.
Permutit Co.
Walker Process Equipment, Inc.

The Story of Water

Our Pilgrim forefathers and their American Indian neighbors conveyed water in buckets or stone jars from springs or creeks. As the population increased, industries were started. Villages became towns, towns became cities, small shops became great manufacturing plants. One of the basic things that made this possible was water.

For domestic use and for industrial use, over 17,000 water distribution systems have been built – dams, reservoirs, filtration plants, sewage systems. Instead of the Pilgrim's bucket and the Indian's stone jar, now we simply open a valve! Our modern cities could not exist, our vaunted American manufacturing industries could not operate without the valves which control their water supply and the fire hydrants which protect them from fire.

At M & H, we like to think that we have played an important part in the American Story of Water. For 34 years we have been making high quality, rugged and efficient valves and hydrants. Thousands of them are in service today in every State in the Union and in many foreign countries.

(No. 11 of a series)

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

SUBSIDIARY OF WALWORTH

Coagulant Aids:
Hagan Chemicals & Controls, Inc.
Nalco Chemical Co.
Philadelphia Quartz Co.

Condensers:
Allis-Chalmers Mfg. Co.
Permutit Co.
United States Pipe & Foundry Co.
Worthington Corp.

Contractors, Water Supply:
Layne & Bowler, Inc.

Controllers, Liquid Level, Rate of Flow:
Bailey Meter Co.
B-I-F Industries, Inc.—Builders
Fischer & Porter Co.
Foxboro Co.
General Filter Co.
Simplex Valve & Meter Co.

Copper Sheets:
Anaconda American Brass Co.

Copper Sulfate:
Tennessee Corp.

Corrosion Control:
Calgon Co.
Harco Corp.
Nalco Chemical Co.
Philadelphia Quartz Co.
Southern Pipe Div. of U.S. Industries

Couplings, Flexible:
Dresser Mfg. Div.
Southern Pipe Div. of U.S. Industries

Covers, Vault:
Ford Meter Box Co.
Wachs, E. H., Co.

Diaphragms, Pump:
Dorr-Oliver Inc.

Engineers and Chemists:
(See Professional Services)

Evaporating Equipment:
Ozark-Mahoning Co.
Permutit Co.

Excavating Equipment:
Charles Machine Works, Inc.
Eimco Corp., The

Feedwater Treatment:
B-I-F Industries, Inc.—Proportioneers
Calgon Co.
Hungerford & Terry, Inc.
Nalco Chemical Co.
Permutit Co.

Ferric Sulfate:
Tennessee Corp.

Filter Materials:
Anthracite Equipment Corp.
Carborundum Co.
General Filter Co.
Johns-Manville Corp.
Northern Gravel Co.
Permutit Co.
Stuart Corp.

Filters, incl. Feedwater:
B-I-F Industries, Inc.—Proportioneers
Dorr-Oliver Inc.
Eimco Corp., The
Permutit Co.
Roberts Filter Mfg. Co.
Ross Valve Mfg. Co.

Filtration Plant Equipment:
B-I-F Industries, Inc.—Builders
B-I-F Industries, Inc.—Omega
Chain Belt Co.
Eimco Corp., The
Filtration Equipment Corp.
General Filter Co.
Golden-Anderson Valve Specialty Co.
Hungerford & Terry, Inc.
Infilco Inc.
F. B. Leopold Co.
Permutit Co.
Roberts Filter Mfg. Co.
Simplex Valve & Meter Co.
Stuart Corp.
Wallace & Tiernan Inc.

Fittings, Copper Pipe:
Dresser Mfg. Div.
Hays Mfg. Co.
Mueller Co.

Fittings, Tees, Ells, etc.:
American Cast Iron Pipe Co.
James B. Clow & Sons
Dresser Mfg. Div.
M & H Valve & Fittings Co.
Morgan Steel Products, Inc.
Southern Pipe Div. of U.S. Industries
Trinity Valley Iron & Steel Co.
United States Pipe & Foundry Co.
R. D. Wood Co.

Flocculating Equipment:
Chain Belt Co.
Dorr-Oliver Inc.
Eimco Corp., The
General Filter Co.
Infilco Inc.
F. B. Leopold Co.
Permutit Co.
Stuart Corp.

Fluoride Chemicals:
American Agricultural Chemical Co.
General Chemical Div., Allied Chemical Corp.
Olin Mathieson Chemical Corp.
Ozark-Mahoning Co.
Tennessee Corp.

Fluoride Feeders:
B-I-F Industries, Inc.—Omega
B-I-F Industries, Inc.—Proportioneers
Fischer & Porter Co.
Wallace & Tiernan Co., Inc.

Furnaces:
Jos. G. Pollard Co., Inc.

Gages, Liquid Level:
Bailey Meter Co.
B-I-F Industries, Inc.—Builders
Fischer & Porter Co.
Simplex Valve & Meter Co.
Wallace & Tiernan Inc.

Gages, Loss of Head, Pressure of Vacuum, Rate of Flow, Sand Expansion:
Bailey Meter Co.
B-I-F Industries, Inc.—Builders
Fischer & Porter Co.
Foxboro Co.
Jos. G. Pollard Co., Inc.
Simplex Valve & Meter Co.
Wallace & Tiernan Inc.

Gasholders:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co.
Pittsburgh-Des Moines Steel Co.

Gaskets, Rubber Packing:
James B. Clow & Sons
Johns-Manville Corp.

Gates, Shear and Sluice:
Armco Drainage & Metal Products, Inc.
James B. Clow & Sons
Mueller Co.
R. D. Wood Co.

Gears, Speed Reducing:
DeLaval Steam Turbine Co.
Worthington Corp.

Glass Standards—Colorimetric Analysis Equipment:
Fischer & Porter Co.
Klett Mfg. Co.
Wallace & Tiernan Inc.

Goosenecks (with or without Corporation Stops):
James B. Clow & Sons
Mueller Co.
Southern Pipe Div. of U.S. Industries

Hydrants:
James B. Clow & Sons
Darling Valve & Mfg. Co.
M. Greenberg's Sons
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Hydrogen Ion Equipment:
Photovolt Corp.
Wallace & Tiernan Inc.

Hypochlorite; see Calcium Hypochlorite; Sodium Hypochlorite

Ion Exchange Materials:
General Filter Co.
Hungerford & Terry, Inc.
Nalco Chemical Co.
Permutit Co.
Roberts Filter Mfg. Co.
Rohm & Haas Co.

Iron, Pig:
Woodward Iron Co.

Iron Removal Plants:
American Well Works
General Filter Co.
Hungerford & Terry, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.

Jointing Materials:
Johns-Manville Corp.
Keasbey & Mattison Co.
Leadite Co., Inc.

Joints, Mechanical, Pipe:
American Cast Iron Pipe Co.
James B. Clow & Sons
Dresser Mfg. Div.
Southern Pipe Div. of U.S. Industries
Trinity Valley Iron & Steel Co.
United States Pipe & Foundry Co.
R. D. Wood Co.

Leak Detectors:
Aqua Survey & Instrument Co.
Jos. G. Pollard Co., Inc.

Lime Slakers and Feeders:
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Dorr-Oliver Inc.
General Filter Co.
Infilco Inc.
Permutit Co.
Wallace & Tiernan Inc.

Locators, Pipe & Valve Box:
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W. S. Darley & Co.
Jos. G. Pollard Co., Inc.

Magnetic Dipping Needles:
Aqua Survey & Instrument Co.
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Meter Boxes:
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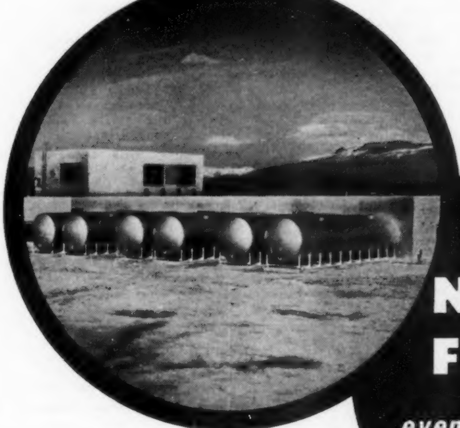
Rockwell Mfg. Co.

Meter Couplings and Yokes:
Badger Meter Mfg. Co.
Dresser Mfg. Div.
Ford Meter Box Co.
Gamon Meter Div., Worthington Corp.



NON-STOP FILTERING

even when backwashing
GFC Multi-Cell Filters

There's no time lost
when backwashing GFC Multi-Cell Filters. While one cell is being backwashed, the other cells provide: **(a)** Water for backwashing that cell **with or without** the use of storage tanks or surface reservoirs. **(b)** Uninterrupted filtering to maintain a continuous flow to service lines. Other important features include low-cost installation and GFC's patented non-clogging "Multi-Plate" underdrains. Write for bulletins and equipment data.

GENERAL FILTER CO.

WATER PROCESS EQUIPMENT AMES, IOWA

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Badger Meter Mfg. Co.
Ford Meter Box Co.
Hersey-Sparling Meter Co.
Neptune Meter Co.
Rockwell Mfg. Co.

Meters, Domestic:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Calmet Meter Div., Worthington Corp.
Gamon Meter Div., Worthington Corp.
Hersey-Sparling Meter Co.
Neptune Meter Co.
Rockwell Mfg. Co.

Meters, Filtration Plant, Pumping Station, Transmission Line:
Bailey Meter Co.
B-I-F Industries, Inc.—Builders
Fischer & Porter Co.
Simplex Valve & Meter Co.

Meters, Industrial, Commercial:
Badger Meter Mfg. Co.
Bailey Meter Co.
B-I-F Industries, Inc.—Builders
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Calmet Meter Div., Worthington Corp.
Fischer & Porter Co.
Gamon Meter Div., Worthington Corp.
Hersey-Sparling Meter Co.
Neptune Meter Co.
Rockwell Mfg. Co.
Simplex Valve & Meter Co.

Mixing Equipment:
General Filter Co.
F. B. Leopold Co.

Motors, Electric:
Allis-Chalmers Mfg. Co.
Marathon Electric Mfg. Corp.
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Paints:
Inertol Co., Inc.
Koppers Co., Inc.
Plastics & Coal Chemicals Div., Allied Chemical Corp.

Pipe, Asbestos-Cement:
Atlas Asbestos Co. Ltd.
Johns-Manville Corp.
Keasbey & Mattison Co.

Pipe, Brass:
Anaconda American Brass Co.

Pipe, Cast Iron (and Fittings):
Alabama Pipe Co.
American Cast Iron Pipe Co.
James B. Clow & Sons
Trinity Valley Iron & Steel Co.
United States Pipe & Foundry Co.
R. D. Wood Co.

Pipe, Cement Lined:
American Cast Iron Pipe Co.
James B. Clow & Sons
Southern Pipe Div. of U.S. Industries
United States Pipe & Foundry Co.
R. D. Wood Co.

Pipe, Concrete:
American Pipe & Construction Co.
Lock Joint Pipe Co.
Vulcan Materials Co.

Pipe, Copper:
Anaconda American Brass Co.

Pipe, Plastic:
American Hard Rubber Co.
Keasby & Mattison Co.
Morgan Steel Products, Inc.
Orangeburg Mfg. Co., Div. of The Flintkote Co.

Pipe, Steel:
Armco Drainage & Metal Products, Inc.
Bethlehem Steel Co.
Morgan Steel Products, Inc.
Southern Pipe Div. of U.S. Industries

Pipe Cleaning Services:
Ace Pipe Cleaning, Inc.
Centriline Corp.
National Power Rodding Corp.
National Water Main Cleaning Co.
Robinson Pipe Cleaning Co.

Pipe Coatings and Linings:
American Cast Iron Pipe Co.
American Hard Rubber Co.
Centriline Corp.
Inertol Co., Inc.
Koppers Co., Inc.
Pipe Linings, Inc.
Plastics & Coal Chemicals Div., Allied Chemical Corp.
Reilly Tar & Chemical Corp.
Southern Pipe Div. of U.S. Industries

Pipe Cutters:
James B. Clow & Sons
Ellis & Ford Mfg. Co.
Pilot Mfg. Co.
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.
Wachs, E. H., Co.
Wheeler Mfg. Corp.

Pipe Jointing Materials; see Jointing Materials

Pipe Locators; see Locators, Pipe

Plugs, Removable:
James B. Clow & Sons
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Potassium Permanganate:
Carus Chemical Co.

Pressure Regulators:
Allis-Chalmers Mfg. Co.
Golden-Anderson Valve Specialty Co.
Mueller Co.
Ross Valve Mfg. Co.

Pumps, Boiler Feed:
DeLaval Steam Turbine Co.

Pumps, Centrifugal:
Allis-Chalmers Mfg. Co.
American Well Works
DeLaval Steam Turbine Co.
Peerless Pump Div.
C. H. Wheeler Mfg. Co.

Pumps, Chemical Feed:
B-I-F Industries, Inc.—Proportioneers
Fischer & Porter Co.
Precision Chemical Pump Corp.
Wallace & Tiernan Inc.

Pumps, Deep Well:
American Well Works
Fiese & Firstenberger
Layne & Bowler, Inc.
Peerless Pump Div.

Pumps, Diaphragm:
Dorr-Oliver Inc.
Wallace & Tiernan Inc.

Pumps, Hydrant:
W. S. Darley & Co.
Jos. G. Pollard Co., Inc.

Pumps, Hydraulic Booster:
Peerless Pump Div.
Ross Valve Mfg. Co.

Pumps, Sewage:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.
Peerless Pump Div.
C. H. Wheeler Mfg. Co.

Pumps, Sump:
DeLaval Steam Turbine Co.
Peerless Pump Div.
C. H. Wheeler Mfg. Co.

Pumps, Turbine:
Fiese & Firstenberger
Layne & Bowler, Inc.
Peerless Pump Div.

Recorders, Gas Density, CO_2, NH_3, SO_2, etc.:
Fischer & Porter Co.
Permutit Co.
Wallace & Tiernan Inc.

Recording Instruments:
Bailey Meter Co.
B-I-F Industries, Inc.—Builders
Fischer & Porter Co.
Simplex Valve & Meter Co.
Wallace & Tiernan Inc.

Reservoirs, Steel:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co.
Pittsburgh-Des Moines Steel Co.

Sand Expansion Gages; see Gages

Sleeves: see Clamps

Sleeves and Valves, Tapping:
James B. Clow & Sons
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Sludge Blanket Equipment:
Eimco Corp., The
General Filter Co.
Infilco Inc.
Permutit Co.

Sodium Aluminate:
Nalco Chemical Co.

Sodium Chloride:
International Salt Co., Inc.

Sodium Fluoride:
American Agricultural Chemical Co.
General Chemical Div., Allied Chemical Corp.

Sodium Hexametaphosphate:
Calgon Co.

Sodium Hypochlorite:
Wallace & Tiernan Inc.

Sodium Silicate:
General Chemical Div., Allied Chemical Corp.
Philadelphia Quartz Co.

Sodium Silicofluoride:
American Agricultural Chemical Co.
General Chemical Div., Allied Chemical Corp.
Tennessee Corp.

Softeners:
Dorr-Oliver Inc.
General Filter Co.
Hungerford & Terry, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.

Softening Chemicals and Compounds:
Calgon Co.
General Filter Co.
International Salt Co., Inc.
Nalco Chemical Co.
Permutit Co.
Tennessee Corp.

Standpipes, Steel:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co.
Pittsburgh-Des Moines Steel Co.

Steel Plate Construction:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co.
Morgan Steel Products, Inc.
Pittsburgh-Des Moines Steel Co.

Stops, Curb and Corporation:
Ford Meter Box Co.
Hays Mfg. Co.
Mueller Co.

Storage Tanks: see Tanks

Strainers, Suction:
James B. Clow & Sons
R. D. Wood Co.

Surface Wash Equipment:
Golden-Anderson Valve Specialty Co.
Permutit Co.

Swimming Pool Sterilization:
B-I-F Industries, Inc.—Builders
B-I-F Industries, Inc.—Omega
B-I-F Industries, Inc.—Proportioneers
Fischer & Porter Co.
Wallace & Tiernan Inc.

Tank Painting and Repair:
Koppers Co., Inc.
National Tank Maintenance Corp.

Tanks, Prestressed Concrete:
Preload Co., Inc.

Tanks, Steel:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Graver Tank & Mfg. Co.
Morgan Steel Products, Inc.
Pittsburgh-Des Moines Steel Co.

Tapping-Drilling Machines:
Hays Mfg. Co.
Mueller Co.
A. P. Smith Mfg. Co.

Tapping Machines, Corp.:
Hays Mfg. Co.
Mueller Co.

Taste and Odor Removal:
B-I-F Industries, Inc.—Builders
B-I-F Industries, Inc.—Proportioneers
General Filter Co.
Industrial Chemical Sales Div.
Permutit Co.
Wallace & Tiernan Inc.

Turbidimetric Apparatus (For Turbidity and Sulfate Determinations):
Wallace & Tiernan Inc.

Turbines, Steam:
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.

Valve Boxes:
James B. Clow & Sons
Ford Meter Box Co.
M & H Valve & Fittings Co.
Mueller Co.
Rockwell Mfg. Co.
A. P. Smith Mfg. Co.
Trinity Valley Iron & Steel Co.
R. D. Wood Co.

Valve-Inserting Machines:
Mueller Co.
A. P. Smith Mfg. Co.

Valve-Operating Units:
B-I-F Industries, Inc.
Filtration Equipment Corp.
Wachs, E. H., Co.
Wheeler, C. H., Mfg. Co.

Valves, Altitude:
Allis-Chalmers Mfg. Co., Hydraulic Div.
Golden-Anderson Valve Specialty Co.
Ross Valve Mfg. Co., Inc.

Valves, Butterfly, Check, Flap, Foot, Hose, Mud and Plug:
Allis-Chalmers Mfg. Co., Hydraulic Div.
B-I-F Industries, Inc.—Builders
James B. Clow & Sons
DeZurik Corp.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
Pelton Div., Baldwin-Lima-Hamilton
Henry Pratt Cc.
Rockwell Mfg. Co.
R. D. Wood Co.

Valves, Detector Check:
Hersey-Sparling Meter Co.

Valves, Electrically Operated:
Allis-Chalmers Mfg. Co., Hydraulic Div.
B-I-F Industries, Inc.—Builders
James B. Clow & Sons
Darling Valve & Mfg. Co.
Golden-Anderson Valve Specialty Co.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
Henry Pratt Co.
Rockwell Mfg. Co.
A. P. Smith Mfg. Co.

Valves, Float:
James B. Clow & Sons
Golden-Anderson Valve Specialty Co.
Henry Pratt Co.
Rockwell Mfg. Co.
Ross Valve Mfg. Co., Inc.

Valves, Gate:
James B. Clow & Sons
Darling Valve & Mfg. Co.
Dresser Mfg. Div.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Hydraulically Operated:
Allis-Chalmers Mfg. Co., Hydraulic Div.
B-I-F Industries, Inc.—Builders
James B. Clow & Sons
Darling Valve & Mfg. Co.
DeZurik Corp.
Golden-Anderson Valve Specialty Co.
Kennedy Valve Mfg. Co.
F. B. Leopold Co.
M & H Valve & Fittings Co.
Mueller Co.
Pelton Div., Baldwin-Lima-Hamilton
Henry Pratt Co.
Rockwell Mfg. Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Large Diameter:
Allis-Chalmers Mfg. Co., Hydraulic Div.
James B. Clow & Sons
Darling Valve & Mfg. Co.
Golden-Anderson Valve Specialty Co.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
Pelton Div., Baldwin-Lima-Hamilton
Henry Pratt Co.
Rockwell Mfg. Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Regulating:
Allis-Chalmers Mfg. Co., Hydraulic Div.
DeZurik Corp.
Golden-Anderson Valve Specialty Co.
Mueller Co.
Henry Pratt Co.
Rockwell Mfg. Co.
Ross Valve Mfg. Co.

Valves, Swing Check:
James B. Clow & Sons
Darling Valve & Mfg. Co.
Golden-Anderson Valve Specialty Co
M & H Valve & Fittings Co.
Mueller Co.
Rockwell Mfg. Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Venturi Tubes:
B-I-F Industries, Inc.—Builders
Rockwell Mfg. Co.
Simplex Valve & Meter Co.

Waterproofing:
Inertol Co., Inc.
Koppers Co., Inc.
Plastics & Coal Chemicals Div., Allied Chemical Corp.

Water Softening Plants; see Softeners

Water Supply Contractors:
Layne & Bowler, Inc.

Water Testing Apparatus:
LaMotte Chem. Products Co.
Wallace & Tiernan Inc.

Water Treatment Plants:
American Well Works
Chain Belt Co.
Chicago Bridge & Iron Co.
Dorr-Oliver Inc.
Eimco Corp., The
General Filter Co.
Hungerford & Terry, Inc.
Infilco Inc.
Permutit Co.
Pittsburgh-Des Moines Steel Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.
Wallace & Tiernan Inc.

Well Drilling Contractors:
Layne & Bowler, Inc.

Well Reconditioning and Formation Testing:
Halliburton Co.
Layne & Bowler, Inc.

Wrenches, Ratchet:
Dresser Mfg. Div.

Zeolite: see Ion Exchange Materials

A complete Buyers' Guide to all water works products and services offered by AWWA Associate Members appears in the 1959 AWWA Directory.

Consulting Engineers: American Water Works Service Co., Inc., Philadelphia, Pa.

Lexington, Kentucky chooses DORRCO Perifilter® System

r new 12 MGD raw river water plant

Lexington Water Company selected a Dorrco PeriFilter System for its new Kentucky River plant for two reasons:

1. Construction and operating costs are lower because pre-treatment unit and filter are installed in the same tank with valves and piping greatly simplified.
2. Expansion to an eventual capacity of 24 mgd can be achieved by simply adding new units.

Basic to the success of the system are the four Dorrco Hydro-Treators®, each surrounded by an annular sand filter, which effectively remove turbidity and color.

Situated on a bluff 345 feet above its river intake, this plant is unique in that it utilizes two service pump stations to lift the water, and an electric tram railway to carry operators up and down the bluff.

For further information on the efficiency of the Dorrco PeriFilter System write Dorr-Oliver Incorporated, Stamford, Conn.

DORR-OLIVER

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